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Vol. 3

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Pilot Program: NRC Severe Reactor Accident Incident Response Training Manual

Response of Licensee and State and Local Officials

U.S. Nuclear Regulatory Commission

Office of Inspection and Enforcement

C. A. Sakenas, T. J. McKenna, C. W. Miller, L. M. Hively, R. W. Sharpe, J. G. Giitter, R. M. Watkins

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Pilot Program: NRC Severe Reactor Accident Incident Response Training Manual

Response of Licensee and State and Local Officials

Manuscript Completed: July 1986
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FOREWORD

Over the past few years the Office of Inspection and Enforcement (IE), Division of Emergency Preparedness and Engineering Response, has undertaken a program to upgrade the NRC capabilities to respond to severe reactor accidents. As part of this effort, basic training sessions have been presented by IE staff to all response personnel (Headquarters and regions). Through the process of providing this training a standard student text has evolved.

This pilot training manual has been written to fill the need for a general text on NRC response to reactor accidents. The manual is intended to be the foundation for a course for all NRC response personnel.

This set of manuals is not licensing guidance. Rather, it is designed to present to NRC personnel the best understanding of response planning for a serious reactor accident.

These draft manuals are intended to change over time as NRC staff continues to gain experience. Suggestions are requested and should be sent to the Incident Response Branch.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

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PREFACE

Response of Licensee and State and Local Officials is the third in a series of volumes that collectively summarize the U.S. Nuclear Regulatory Commission (NRC) emergency response during severe power reactor accidents. This volume describes in general terms the planned response of the licensee and state and local officials during a severe accident. Other volumes in the series and the subjects they address are:

- Volume 1 -- Overview and Summary of Major Points
- Volume 2 -- Severe Reactor Accident Overview
- Volume 4 -- Public Protective Actions--Predetermined Criteria and Initial Actions
- Volume 5 -- U.S. Nuclear Regulatory Commission Response

Each volume serves, respectively, as the text for a course of instruction in a series of courses for NRC response personnel. These materials do not provide guidance or license requirements for NRC licensees. The volumes have been organized into those training modules to accommodate the scheduling and duty needs of participating NRC staff. Each volume is accompanied by an appendix of slides that can be used to present this material. The slides are called out in the text.

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CONTENTS

PREFACE iii

LIST OF FIGURES vii

LIST OF TABLES ix

LIST OF ACRONYMS AND INITIALISMS FOR VOLUMES 1-5 xi

1. LICENSEE RESPONSE PLANS AND PROCEDURES 1
   1.1 OBJECTIVES 1
   1.2 PREPLANNING REQUIREMENTS 2
      1.2.1 Basis for Licensee Plans 2
      1.2.2 Major Requirements 3
   1.3 ROLES IN AN EMERGENCY 3
      1.3.1 Role of the U.S. Nuclear Regulatory Commission 3
      1.3.2 Responsibilities of Licensee 4
      1.3.3 Responsibilities of State and Local Agencies 5
   1.4 PREPLANNING AREA (EMERGENCY PLANNING ZONES) 5
      1.4.1 Plume Exposure Pathway 6
      1.4.2 Ingestion Pathway Emergency Planning Zone 8
   1.5 EMERGENCY OPERATING PROCEDURES 9
   1.6 CORE CONDITION ASSESSMENT 11
   1.7 EMERGENCY CLASSIFICATION SYSTEM 11
      1.7.1 Emergency Action Levels 13
      1.7.2 Emergency Class Descriptions 20
         1.7.2.1 Unusual Event 20
         1.7.2.2 Alert 20
         1.7.2.3 Site Area Emergency 23
         1.7.2.4 General Emergency 24
         1.7.2.5 Protective Action Recommendations 24
   1.8 EMERGENCY RESPONSE CENTERS AND ORGANIZATIONS 25
      1.8.1 Control Room 25
      1.8.2 Technical Support Center 26
      1.8.3 Operations Support Center 26
      1.8.4 Emergency Operations Facility 27
      1.8.5 Flow of Authority and Responsibility 27
   1.9 RADIOLOGICAL ASSESSMENT CAPABILITIES 28
      1.9.1 Increased Effluent Monitor Coverage and Range 28
      1.9.2 Postaccident Sampling 29
      1.9.3 Sampling and Analysis of Plant Effluents 29
      1.9.4 Field Monitoring 30
   1.10 MAJOR POINTS 30

2. RESPONSE OF STATE AND LOCAL ORGANIZATIONS 33
   2.1 OBJECTIVES 33
   2.2 EMERGENCY RESPONSE PLANS 33
   2.3 DELINEATION OF RESPONSIBILITY 34

BEST COPY AVAILABLE

2.4 PROTECTIVE ACTIONS AND NOTIFICATION OF PUBLIC 34
2.5 EVACUATION TIME ESTIMATES 35
2.6 DOSE PROJECTIONS AND FIELD MONITORING 37
2.7 LOCATION OF AUTHORITY AND RESPONSIBILITY. 38
2.8 MAJOR POINTS. 38

APPENDIX A. SLIDES RELATING TO VOLUME 3 OF THE SEVERE REACTOR ACCIDENT INCIDENT RESPONSE TRAINING MANUAL. 41

BEST COPY AVAILABLE

LIST OF FIGURES

Figure		Page
1.1	Relationship of thermocouple temperature to cladding failure.	12
1.2	Pressurized water reactor (PWR) event tree for emergency classification	15
1.3	Boiling water reactor (BWR) event tree for emergency classification	16
1.4	Typical relationship among critical safety functions (CSFs), fission product barriers, and classes of emergency	18
2.1	Flow chart showing steps from detection of an event in the control room to notification of the public	36

BEST COPY AVAILABLE

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LIST OF TABLES

Table		Page
1.1	Sample initiating condition and examples of accompanying Emergency Action Levels (EALs).	14
1.2	Example of timing for boiling water reactor (BWR) general emergency sequences	19
1.3	Emergency class descriptions.	21
1.4	Emergency class response.	22

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LIST OF ACRONYMS AND INITIALISMS FOR VOLUMES 1-5

ALARA	As low as reasonably achievable
AMS	Aerial Measurements System(s)
ARAC	Atmospheric Release Advisory Capability
ASC	Administrative Support Coordinator
AST	Administrative Support Team
BT	Base Team (NRC Regional Office)
BWR	Boiling Water Reactor
CDPA	Civil Defense Preparedness Agency
CFA	Cognizant Federal Agency
CFR	Code of Federal Regulations
CL	Congressional Liaison
CRD	Control rod drive
CRDHS	Control rod drive hydraulic system
CSF	Critical Safety Function
DBA	Design Basis Accident
DOC	Department of Commerce, U.S.
DOD	Department of Defense, U.S.
DOE	Department of Energy, U.S.
DOI	Department of Interior, U.S.
DOT	Department of Transportation, U.S.
DSO	Director of Site Operations
EAL	Emergency Action Level
ECCS	Emergency Core Cooling System
EDO	Executive Director of Operations
ENS	Emergency Notification System
EO	Emergency Officer
EOF	Emergency Operations Facility
EOP	Emergency Operating Procedure
EPA	Environmental Protection Agency, U.S.
EPRI	Electrical Power Research Institute
EPZ	Emergency Planning Zone
ERC	Emergency Response Coordinator
ERM	Emergency Response Manager
ERO	Emergency Response Organization
ERT	Emergency Response Team (FEMA organization)
ESF	Engineered Safety Feature
EST	Emergency Support Team (FEMA organization)
ET	NRC Executive Team
ETA	Estimated time of arrival
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration, U.S.
FEMA	Federal Emergency Management Agency
FRC	Federal Response Center
FRERP	Federal Radiological Emergency Response Plan
FRMAC	Federal Radiological Monitoring and Assessment Center
FRMAP	Federal Radiological Monitoring and Assessment Plan
FTS	Federal Telephone System
GLC	Government Liaison Coordinator
GLM	Government Liaison Manager

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GLO	Government Liaison Officer
GLT	Government Liaison Team
HHS	Health and Human Services, U.S. Department of
HOO	NRC Headquarters Operations Officer
HPCI	High-pressure coolant injection
HPCS	High-pressure core spray
HPN	Health Physics Network
HQ	NRC Headquarters
HUD	Housing and Urban Development, U.S. Department of
IE	NRC Office of Inspection and Enforcement
ICRP	International Commission on Radiological Protection
IDAS	Interactive Dose Assessment System
IRB	Incidence Response Branch
IRC	Regional NRC Incident Response Center
IRDAM	Interactive Rapid Dose Assessment Model
JIC	Joint Information Center
LC	Liaison Coordinator
LNO	Liaison Officer
LOCA	Loss of Coolant Accident
LPCI	Low-pressure coolant injection
LPCS	Low-pressure core spray
LT	Liaison Team
LWR	Light Water Reactor
NCS	National Communication System
NMSS	NRC Office of Nuclear Material Safety and Safeguards
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission, U.S.
NRR	NRC Office of Nuclear Reactor Regulation
NWS	National Weather Service
OC	Operations Center
OSC	Operations Support Center (site)
PA	Public Affairs
PAC	Public Affairs Coordinator
PAG	Protective Action Guides
PAM	Public Affairs Manager
PAR	Protective Action Recommendation
PASS	Post-accident Sampling Systems
PAT	Public Affairs Team
PMC	Protective Measures Coordinator
PMM	Protective Measures Manager
PMT	Protective Measures Team
P-T	Pressure-Temperature
PWR	Pressurized Water Reactor
RA	Regional Administrator
RAT	Radiological Assistance Team
RBE	Relative biological effectiveness
RCIC	Reactor core isolation cooling
RCT	Response Coordination Team
RDO	Regional Duty Officer
R.G.	Regulatory Guide
RHR	Residual heat removal
RI	Resident Inspector

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RM	Resource Manager
RO	Regional Office
RSC	Reactor Safety Coordinator
RSM	Reactor Safety Manager
RST	Reactor Safety Team
SC	Safeguards/Security Coordinator
SFO	Senior FEMA Official
SGC	Safeguards/Security Coordinator
SGT	Safeguards Team
SI	International System (of measurement)
SLC	Standby liquid control
SM	Safeguards/Security Manager
SO	Status Officer
ST	Site Team
STL	Site Team Leader
TLD	Thermoluminescent dosimeter
TMI-2	Three Mile Island--Unit 2
TSC	Technical Support Center
USDA	U.S. Department of Agriculture
WHO	World Health Organization

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1. LICENSEE RESPONSE PLANS AND PROCEDURES

Slides 1 and 2

1.1 OBJECTIVES

Following completion of this section, the student should be able to describe:

- the responsibilities of the licensee during an accident;
- what preparations have been made in the plume Emergency Planning Zone (EPZ) and describe a typical Emergency Planning Zone boundary;
- the four classes of emergencies, and, in general, the action taken by the licensee and off-site officials for each;
- how events are classified and the basis for these classification systems [emergency action levels (EALs)];
- the function of the control room, Technical Support Center (TSC), and the Emergency Operations Facility (EOF) during an event and how responsibility flows from one to the other; and
- the licensee's accident assessment monitoring and dose assessment capabilities.

To understand many of the concepts discussed in this volume, the student must first understand the concepts discussed in Vol. 2.

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1.2 PREPLANNING REQUIREMENTS

1.2.1 Basis for Licensee Plans

Included in Vol. 1 of this document is a bibliography of material that the student should consult for more information on licensee requirements. More specifically,

Slide 3

1. NUREG 0396,* NUREG 1131,* and Information Notice 83-28 discuss the foundation for the current emergency preparedness concepts;

2. Title 10, Code of Federal Regulations (CFR) Pt. 50.47 and Appendix E contain the basic requirements for emergency preparedness;

3. NUREG 0654 [Regulatory Guide (R.G.) 1.101, rev. 2]* contains the criteria to be used in developing and assessing an emergency plan; and

4. NUREG 0737, Supp. 1* clarifies the requirements for the emergency organization and emergency centers.

Licensees have developed plans and procedures for emergency response in accordance with the above criteria. These are available at U.S. Nuclear Regulatory Commission (NRC) Headquarters (HQ) and regional offices for each operating reactor, and they should be consulted in the event of an emergency.

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* See Vol. 1, Appendix A, "Bibliography for Volumes 1-5."

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1.2.2 Major Requirements

Slide 4

The emergency preparedness requirements for licensees are extensive. However, this discussion will be limited to only those requirements that affect the NRC's role of monitoring protective actions, such as event detection and classification, Emergency Planning Zones, radiological monitoring and dose assessment, and emergency organizations and response centers.

1.3 ROLES IN AN EMERGENCY

Slide 5

1.3.1 Role of the U.S. Nuclear Regulatory Commission

Since the Three Mile Island--Unit 2 (TMI-2) incident, extensive improvements in emergency planning and preparedness have been accomplished at nuclear power plants and in areas near the plants (up to about 10 miles). There have been improvements in the development of (1) emergency operating procedures (EOPs) used to direct operators' response, (2) Emergency Action Levels to help operators recognize the severity of an event, (3) enhanced procedures for recommending prompt protective actions, and (4) improved accident assessment capabilities. It is important that the NRC response personnel understand that extensive preplanning has been completed to assist in early decision making. They must also understand that their role should be one of monitoring the licensee's actions and providing assistance to the licensee.

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1.3.2 Responsibilities of Licensee

Slide 6

In the event of an emergency, the licensee has two primary functions: (1) control the event and (2) notify off-site officials and, where appropriate, recommend protective actions off site. The licensee's first priority, then, is to protect the core by ensuring that the following crucial safety functions are maintained by

1. making the core subcritical and keeping it there,
2. keeping the water flowing through the core,
3. keeping the core covered with water,
4. providing makeup for water boiled off, and
5. removing decay heat from the core to an outside heat sink.

The licensee must also take action to prevent or reduce off-site consequences by

1. maintaining reactor containment and the Engineered Safety Feature (ESF) systems,
2. controlling radionuclide releases, and
3. recommending appropriate protective actions to off-site officials.

Licensees have developed Emergency Operating Procedures for use by the control room staff in responding to emergency conditions. These Emergency Operating Procedures are discussed later.

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In parallel with attempts to correct the problem, the licensee must notify off-site officials of emergency declaration promptly (within 15 min).

The licensee recommends initial protective actions to off-site officials because the licensee is the only one who would have a true and an early understanding of core and containment conditions. Furthermore, if an actual off-site radionuclide release occurs, the licensee is responsible for monitoring that release to ensure that actions recommended off site are appropriate (i.e., that initial protective action recommendations/decisions continue to be valid based on current, actual monitoring data). Volume 4 contains a discussion of protective action concepts and guidance for licensees.

1.3.3 Responsibilities of State and Local Agencies

Slide 7

State and local agencies are charged with protecting the public from the off-site consequences that might result from a power plant accident. These organizations have the ultimate responsibility for notifying the public to take protective actions in the event of a severe accident. State and local officials base their decisions on the recommendations of the licensee. The licensee cannot order an evacuation surrounding the plant; the licensee can only make such a recommendation to the appropriate off-site officials. Those officials must make the decision to notify the public to implement any protective actions.

1.4 PREPLANNING AREA (EMERGENCY PLANNING ZONES)

Specific plume and ingestion Emergency Planning Zones have been established around each nuclear reactor plant site. These Emergency Planning Zones were established so that the public can be notified to implement appropriate protective actions in an

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efficient and a timely manner in the event of a real emergency.

1.4.1 Plume Exposure Pathway

Slide 8

The plume exposure Emergency Planning Zone is an area approximately 10 miles in radius around the power plant. The size (about a 10-mile radius) of the plume exposure Emergency Planning Zone was based primarily on the following considerations.

- Projected doses from the traditional design basis accidents would not exceed Environmental Protection Agency Protective Action Guide (PAG) levels outside the zone.

- Projected doses from most core melt sequences would not exceed Protective Action Guide upper levels outside the zone.

- For the worst case core melt sequences, immediate life-threatening doses would generally not occur outside the zone. (For most analyzed severe accidents, life-threatening doses are limited to within 2 to 3 miles of the site.)

- Detailed planning within 10 miles would provide a substantial base for expansion of response efforts in the event that this proved necessary.

It is unlikely that any immediate protective actions would be required beyond the plume exposure pathway Emergency Planning Zone. This area is of sufficient size for actions within this zone to provide for substantial reduction in early severe health effects (injuries or death) in the event of a worst case core melt accident. This Emergency Planning Zone is that area

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requiring possible immediate action in the event of an accident to reduce risk to the public.

Slides 9 and 10

The boundaries of the plume Emergency Planning Zone take into account local features (e.g., roads, rivers, or features, such as a peninsula, that extend the zone beyond 10 miles). This is the area for which extensive preparations have been accomplished, such as:

Slide 11

1. provisions for prompt decision making on protective actions for the public by all responsible parties;

2. development of evacuation plans;

3. provisions for informing the public of emergency plans and procedures (i.e., a public education program);

4. provisions for promptly (within 15 min of the time that state and local officials are notified) alerting and informing the public of the actions to be taken (e.g., siren system and radio messages);

5. provisions for maintaining 24-hr communication between the licensee and state and local officials;

6. provisions for radiological monitoring in the event of an off-site radioactivity release; and

7. provisions for activating and maintaining emergency operations centers.

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1.4.2 Ingestion Pathway Emergency Planning Zone

Slide 12

The ingestion pathway Emergency Planning Zone is the area in which plans exist for protecting the public from the consumption of food contaminated with radioactive material and for which there is considerable time (hours to days) for action to reduce risks. Thus, the level of preparation is much less in this Emergency Planning Zone than it is in the plume exposure pathway Emergency Planning Zone. Also, the preparations that are made for this Emergency Planning Zone are typically effected at the state level rather than at the local level.

In this Emergency Planning Zone, the concern is for the interdiction of foodstuffs rather than the avoidance of exposure to the plume itself. The area of this Emergency Planning Zone generally encompasses a 50-mile radius around the plant site. The size of the ingestion exposure Emergency Planning Zone (about 50 miles in radius, which also includes the 10-mile radius plume exposure Emergency Planning Zone) was selected for the following reasons.

Slide 13

- The downwind range within which contamination will generally not exceed the Protective Action Guides is limited to about 50 miles from a power plant because of wind shifts during the release and travel periods.

- There may be conversion of atmospheric iodine (i.e., iodine suspended in the atmosphere for long time periods) to chemical forms that do not readily enter the ingestion pathway.

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- Much of any particulate material in a radioactive plume would have been deposited on the ground within about 50 miles of the facility.

- The likelihood of exceeding ingestion pathway Protective Action Guide levels at 50 miles is comparable to the likelihood of exceeding plume exposure pathway Protective Action Guide levels at 10 miles.

Except for the most severe accidents, immediate action is not critical for food and agricultural produce because of the additional time involved when compared to the time frame associated with the plume exposure Emergency Planning Zone. Preplanned actions for this Emergency Planning Zone ordinarily will be implemented by local agencies upon the direction of state agencies.

Protective actions for this Emergency Planning Zone would generally include removal of grazing animals to stored feed and restriction of product consumption and water usage.

1.5 EMERGENCY OPERATING PROCEDURES

Slide 14

Prior to the incidents at Three Mile Island, the procedures in the control room to correct a problem were essentially "event-oriented." They described the steps which the operator should take given the occurrence of certain preselected, preanalyzed events. These procedures were typically limited to transient events or loss-of-coolant events followed by successful operation of all safety systems designed to respond to these events.

Much of the post-Three Mile Island emergency procedures activity has been devoted to the development of "function-oriented" or "symptom-oriented" procedures to replace (or at least significantly augment) the event-specific procedures.

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The basic assumption underlying these alternate approaches is that there is a limited set of critical safety functions (CSFs), which, if successfully performed automatically or through manual action, result in a "safe" condition for the plant. Thus, the basic design goal of the plant safety systems and the ultimate goal of all operator actions is to ensure the performance of these critical functions. The procedures relate critical safety functions performance to specific plant/control room instruments. It is important to note that, in general, the Emergency Operating Procedures address actions that lead up to but do not include actions to be taken after core damage. Therefore, the operators may not have procedures to help them once the core has been damaged.

Slide 15

The attractiveness of this "critical functions" concept evolves from the implication that the operator need only monitor a relatively few pieces of information to ascertain the safety of the plant. While there are a limited number of critical functions (or parameters) which indicate the performance of these functions, there are virtually an unlimited number of events (with a wide variety of symptoms) that can affect the performance of these functions. The operator can carry out his duties by focusing on these critical functions without regard to the specific events that have occurred. The technical guidelines along which individual plant Emergency Operating Procedures have been developed should be reviewed by the Reactor Safety Team (RST) at the start of an event. This will provide valuable insight into the question of "why is the operator doing that?" In many cases, the answer is "because the Emergency Operating Procedure calls for it."

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1.6 CORE CONDITION ASSESSMENT

Slide 16

As a result of shortcomings identified in the Three Mile Island accident, licensees have installed additional instrumentation to detect inadequate core cooling, developed core condition assessment procedures, and conducted training on core condition assessment.

Slide 17

Licensees have also developed procedures to assess the extent of core damage as discussed in Vol. 2. These procedures indicate the relationship of various plant instruments (e.g., containment monitor, water level, or thermocouple readings) and the extent of core damage. These relationships must be used with caution and be considered only gross indicators of the extent of core damage. Figure 1.1 is an example of the relationship of thermocouple temperature to cladding failure.

1.7 EMERGENCY CLASSIFICATION SYSTEM

Four class of emergencies--Unusual Event, Alert, Site Area Emergency, and General Emergency--have been established by NRC regulations. The specific class of emergency that is declared is based on conditions that trigger the Emergency Action Levels discussed below. Typically, licensees have established specific Emergency Plan Implementation Procedures (EPIPs) for each emergency class that are to be implemented by the control room staff. The importance of correct classification cannot be overly emphasized. The event classification initiates all appropriate actions for that class. Both over- and underreaction could have serious adverse consequences. The specific classification procedures (i.e., Emergency Action Levels) for a given nuclear power plant are located in the

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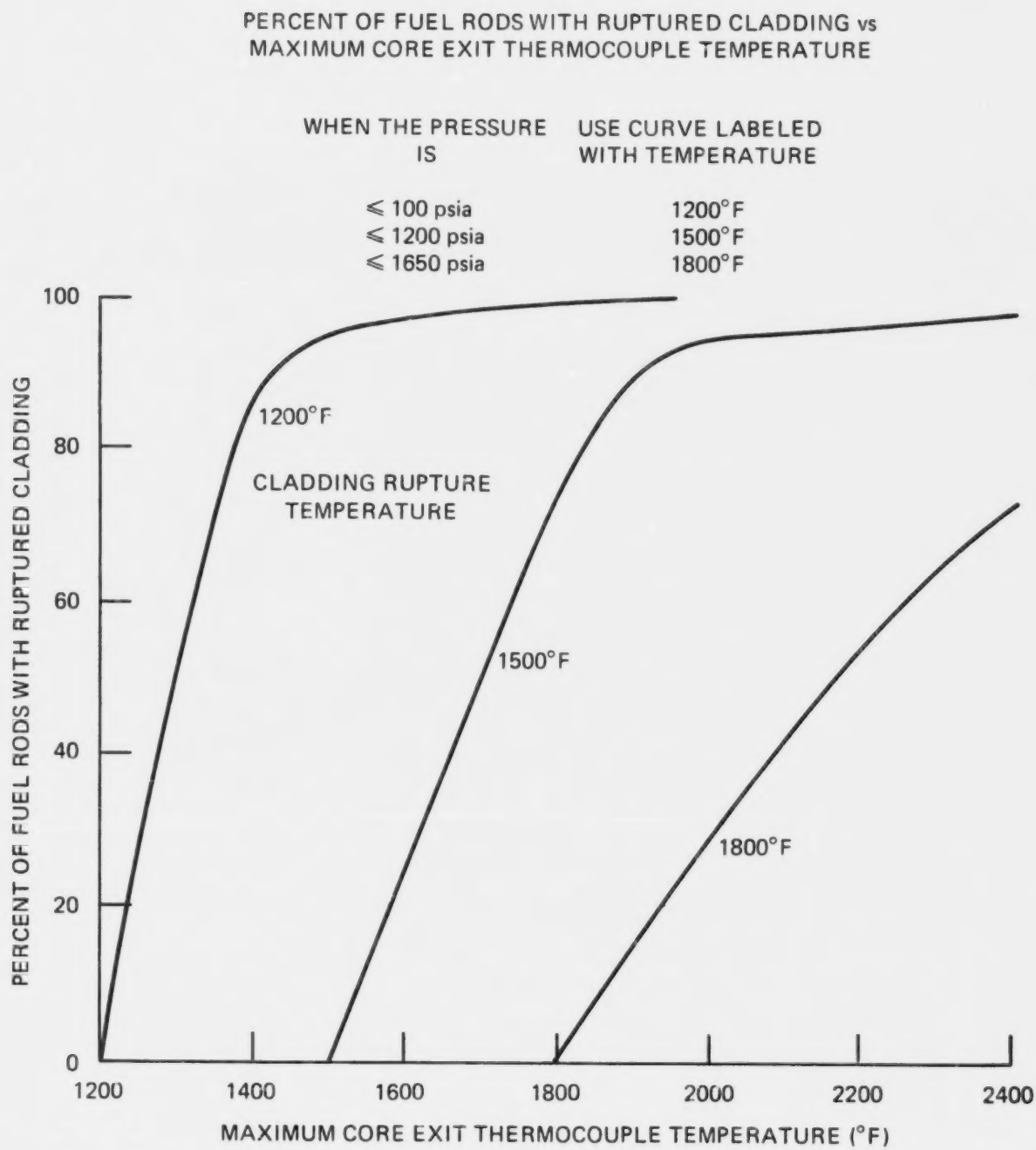

Fig. 1.1. Relationship of thermocouple temperature to cladding failure.

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Region Incident Response Centers (IRCs) and the Headquarters Operations Center.

1.7.1 Emergency Action Levels

Slide 18

As discussed in Vol. 2, licensees have established Emergency Action Levels based on control room instrument readings (e.g., 1000 R/hr contaminant monitor reading or 2000°F thermocouple) that indicate the scope of an emergency. NRC guidance requires that Emergency Action Levels be established for a full range of events from situations that indicate just a potential problem to actual core damage (General Emergency).

The Emergency Action Levels are extremely important because they are used as trigger levels for the declaration of emergencies and initiation of predetermined activities that lead to immediate, early actions (e.g., activation of organization, notifications, and protective actions).

Slide 19

Each licensee's emergency action plan contains a list of Emergency Action Levels which are used by the operators in assessing the level of response needed. Most licensees have established their Emergency Action Levels for each of the 60 example initiating conditions provided in NUREG 0654.* In many cases, this results in a very long list of diagnostic control room parameters, as can be seen from the sample shown in Table 1.1. Some licensees have streamlined this approach by using flow charts and other visual aids. Figures 1.2 and 1.3** show the NUREG 0654 example initiating conditions and their relationships to basic plant conditions and event classes.

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* See Vol. 1, Appendix A, "Bibliography for Volumes 1-5."

** Figures developed by John Hickman, NRC.

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Table 1.1. Sample initiating condition and examples of accompanying Emergency Action Levels (EALs)

Initiating condition No. 1	Emergency Action Levels
Known loss of coolant accident (LOCA) greater than makeup pump capacity	Low reactor water level (-134 in.) on level/pressure recorder 1B21-R623B, panel 1H12-P601 or High drywell pressure (+1.8 lb) on pressure indicators CM010 and/or CM021, panel 1PM06J with Water level below (and failure to return to) top of active fuel as indicated on fuel zone level indicator 1B21-R6210, panel 1H13-P601 (-150 in. +50 in. range with "0" corresponding to top of active fuel), following a time delay of 3 min

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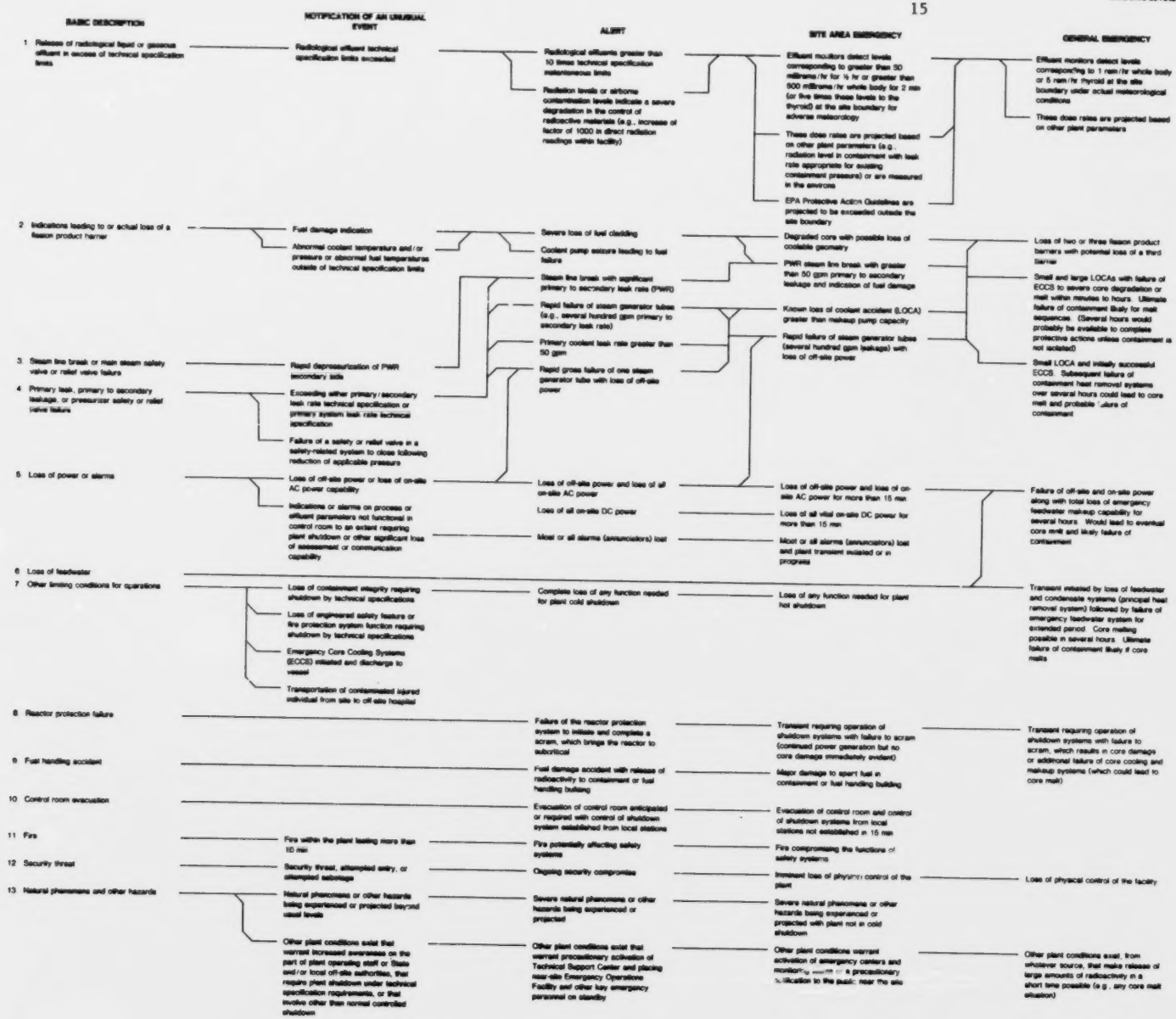
BASIC DESCRIPTION
NOTIFICATION OF AN UNUSUAL EVENT
ALERT
SITE AREA EMERGENCY
GENERAL EMERGENCY
1 Release of radiological liquid or gaseous effluent in excess of technical specification limits
Radiological effluent technical specification limits exceeded
Radiological effluents greater than 10 times technical specification instantaneous limits
Radiation levels or airborne contamination levels indicate a severe degradation in the control of radioactive materials (e.g., increase of factor of 1000 in direct radiation readings within facility)
Effluent monitors detect levels corresponding to greater than 50 millirems/hr for ½ hr or greater than 500 millirems/hr whole body for 2 min (or five times these levels to the thyroid) at the site boundary for adverse meteorology
These dose rates are projected based on other plant parameters (e.g., radiation level in containment with leak rate appropriate for existing containment pressure) or are measured in the environs
EPA Protective Action Guidelines are projected to be exceeded outside the site boundary
Effluent monitors detect levels corresponding to 1 rem/hr whole body or 5 rem/hr thyroid at the site boundary under actual meteorological conditions
These dose rates are projected based on other plant parameters
2 Indications leading to or actual loss of a fission product barrier
Fuel damage indication
Abnormal coolant temperature and/or pressure or abnormal fuel temperatures outside of technical specification limits
Severe loss of fuel cladding
Coolant pump seizure leading to fuel failure
Degraded core with possible loss of coolable geometry
PWR steam line break with greater than 50 gpm primary to secondary leakage and indication of fuel damage
Loss of two or three fission product barriers with potential loss of a third barrier
3 Steam line break or main steam safety valve or relief valve failure
Rapid depressurization of PWR secondary side
Steam line break with significant primary to secondary leak rate (PWR)
Rapid failure of steam generator tubes (e.g., several hundred gpm primary to secondary leak rate)
Known loss of coolant accident (LOCA) greater than makeup pump capacity
Small and large LOCAs with failure of ECCS to severe core degradation or melt within minutes to hours. Ultimate failure of containment likely for melt sequences. (Several hours would probably be available to complete protective actions unless containment is not isolated)
4 Primary leak, primary to secondary leakage, or pressurizer safety or relief valve failure
Exceeding either primary/secondary leak rate technical specification or primary system leak rate technical specification
Failure of a safety or relief valve in a safety-related system to close following reduction of applicable pressure
Primary coolant leak rate greater than 50 gpm
Rapid failure of steam generator tubes (several hundred gpm (leakage) with loss of off-site power
Small LOCA and initially successful ECCS. Subsequent failure of containment heat removal systems over several hours could lead to core melt and probable failure of containment
5 Loss of power or alarms
Loss of off-site power or loss of on-site AC power capability
Indications or alarms on process or effluent parameters not functional in control room to an extent requiring plant shutdown or other significant loss of assessment or communication capability
Loss of off-site power and loss of all on-site AC power
Loss of all on-site DC power
Most or all alarms (annunciators) lost
Loss of off-site power and loss of on-site AC power for more than 15 min
Loss of all vital on-site DC power for more than 15 min
Most or all alarms (annunciators) lost and plant transient initiated or in progress
Failure of off-site and on-site power along with total loss of emergency feedwater makeup capability for several hours. Would lead to eventual core melt and likely failure of containment
6 Loss of feedwater
7 Other limiting conditions for operations
Loss of containment integrity requiring shutdown by technical specifications
Loss of engineered safety feature or fire protection system function requiring shutdown by technical specifications
Emergency Core Cooling Systems (ECCS) initiated and discharge to vessel
Transportation of contaminated injured individual from site to off-site hospital
Complete loss of any function needed for plant cold shutdown
Loss of any function needed for plant hot shutdown
Transient initiated by loss of feedwater and condensate systems (principal heat removal system) followed by failure of emergency feedwater system for extended period. Core melting possible in several hours. Ultimate failure of containment likely if core melts
8 Reactor protection failure
Failure of the reactor protection system to initiate and complete a scram, which brings the reactor to subcritical
Transient requiring operation of shutdown systems with failure to scram (continued power generation but no core damage immediately evident)
Transient requiring operation of shutdown systems with failure to scram, which results in core damage or additional failure of core cooling and makeup systems (which could lead to core melt)
9 Fuel handling accident
Fuel damage accident with release of radioactivity to containment or fuel handling building
Major damage to spent fuel in containment or fuel handling building
10 Control room evacuation
Evacuation of control room anticipated or required with control of shutdown system established from local stations
Evacuation of control room and control of shutdown systems from local stations not established in 15 min
11 Fire
Fire within the plant lasting more than 10 min
Fire potentially affecting safety systems
Fire compromising the functions of safety systems
12 Security threat
Security threat, attempted entry, or attempted sabotage
Ongoing security compromise
Imminent loss of physical control of the plant
Loss of physical control of the facility
13 Natural phenomena and other hazards
Natural phenomena or other hazards being experienced or projected beyond usual levels
Other plant conditions exist that warrant increased awareness on the part of plant operating staff or State and/or local off-site authorities, that require plant shutdown under technical specification requirements, or that involve other than normal controlled shutdown
Severe natural phenomena or other hazards being experienced or projected
Other plant conditions exist that warrant precautionary activation of Technical Support Center and placing near-site Emergency Operations Facility and other key emergency personnel on standby
Severe natural phenomena or other hazards being experienced or projected with plant not in cold shutdown
Other plant conditions warrant activation of emergency centers and monitoring teams or a precautionary notification to the public near the site
Other plant conditions exist from whatever source, that make release of large amounts of radioactivity in a short time possible (e.g., any core melt situation)

Fig. 1.2. Pressurized water reactor (PWR) event tree for emergency classification.

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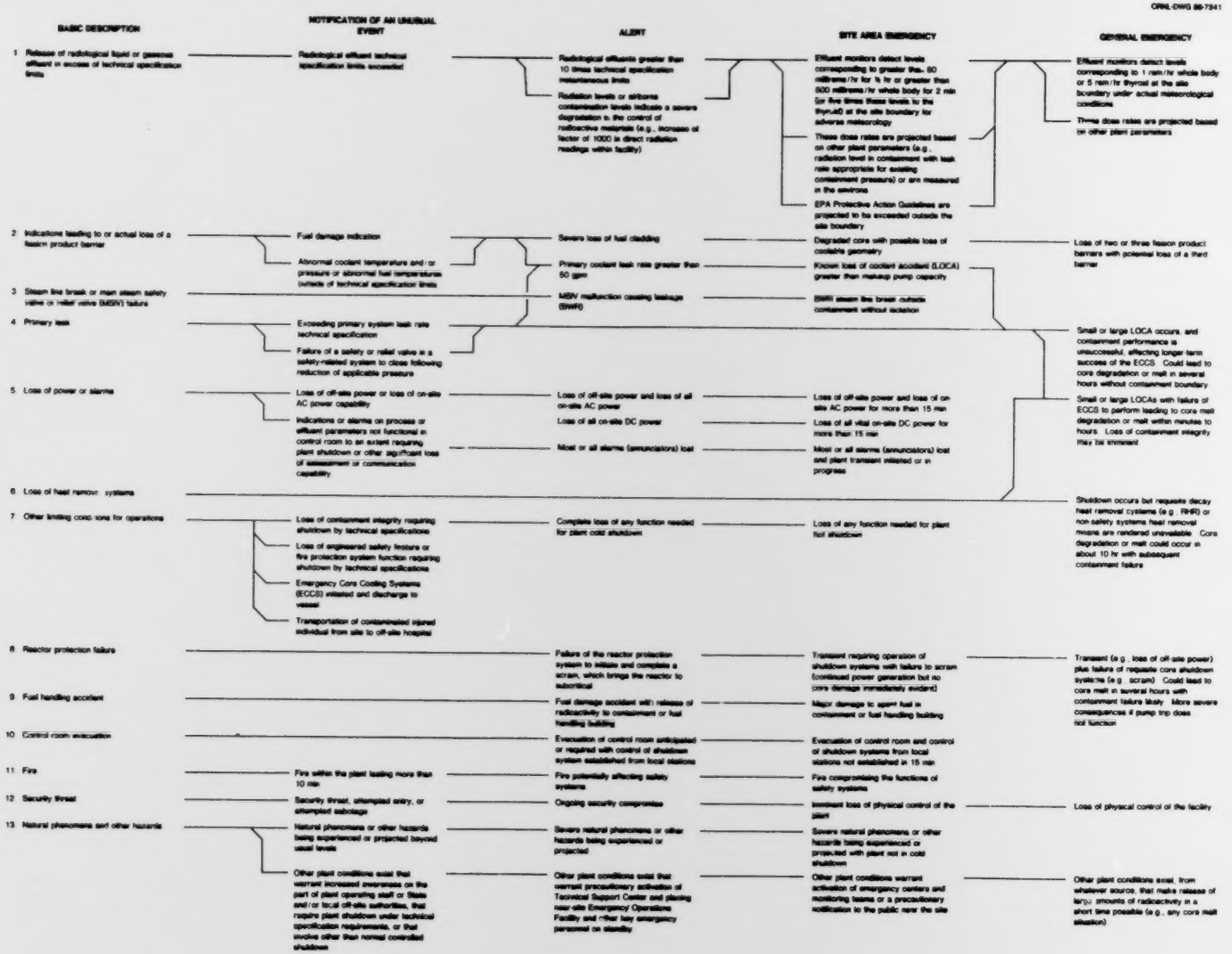
ORNL-DWG 88-7341
BASIC DESCRIPTION
NOTIFICATION OF AN UNUSUAL EVENT
ALERT
SITE AREA EMERGENCY
GENERAL EMERGENCY
1 Release of radiological liquid or gaseous effluent in excess of technical specification limits
Radiological effluent technical specification limits exceeded
Radiological effluents greater than 10 times technical specification instantaneous limits
Radiation levels or airborne contamination levels indicate a severe degradation in the control of radioactive materials (e.g., increase of factor of 1000 in direct radiation readings within facility)
Effluent monitors detect levels corresponding to greater than 50 millirems/hr for 1/2 hr or greater than 500 millirems/hr whole body for 2 min (or five times these levels to the thyroid) at the site boundary for adverse meteorology
These dose rates are projected based on other plant parameters (e.g., radiation level in containment with leak rate appropriate for existing containment pressure) or are measured in the environs
EPA Protective Action Guidelines are projected to be exceeded outside the site boundary
Effluent monitors detect levels corresponding to 1 rem/hr whole body or 5 rem/hr thyroid at the site boundary under actual meteorological conditions
Three dose rates are projected based on other plant parameters
2 Indications leading to or actual loss of a fission product barrier
Fuel damage indication
Abnormal coolant temperature and / or pressure or abnormal fuel temperatures outside of technical specification limits
Severe loss of fuel cladding
Primary coolant leak rate greater than 50 gpm
Degraded core with possible loss of coolable geometry
Known loss of coolant accident (LOCA) greater than makeup pump capacity
Loss of two or three fission product barriers with potential loss of a third barrier
3 Steam line break or main steam safety valve or relief valve (MSIV) failure
MSIV malfunction causing leakage (BWR)
BWR steam line break outside containment without isolation
4 Primary leak
Exceeding primary system leak rate technical specification
Failure of a safety or relief valve in a safety-related system to close following reduction of applicable pressure
Small or large LOCA occurs, and containment performance is unsuccessful, affecting longer term success of the ECCS. Could lead to core degradation or melt in several hours without containment boundary
5 Loss of power or alarms
Loss of off-site power or loss of on-site AC power capability
Indications or alarms on process or effluent parameters not functional in control room to an extent requiring plant shutdown or other significant loss of assessment or communication capability
Loss of off-site power and loss of all on-site AC power
Loss of all on-site DC power
Most or all alarms (annunciators) lost
Loss of off-site power and loss of on-site AC power for more than 15 min
Loss of all vital on-site DC power for more than 15 min
Most or all alarms (annunciators) lost and plant transient initiated or in progress
Small or large LOCAs with failure of ECCS to perform leading to core melt degradation or melt within minutes to hours. Loss of containment integrity may be imminent
6 Loss of heat removal systems
Shutdown occurs but requires decay heat removal systems (e.g., RHR) or non-safety systems heat removal means are rendered unavailable. Core degradation or melt could occur in about 10 hr with subsequent containment failure
7 Other limiting conditions for operations
Loss of containment integrity requiring shutdown by technical specifications
Loss of engineered safety feature or fire protection system function requiring shutdown by technical specifications
Emergency Core Cooling Systems (ECCS) initiated and discharge to vessel
Transportation of contaminated injured individual from site to off-site hospital
Complete loss of any function needed for plant cold shutdown
Loss of any function needed for plant hot shutdown
8 Reactor protection failure
Failure of the reactor protection system to initiate and complete a scram, which brings the reactor to subcritical
Transient requiring operation of shutdown systems with failure to scram (continued power generation but no core damage immediately evident)
Transient (e.g., loss of off-site power) plus failure of requisite core shutdown systems (e.g., scram). Could lead to core melt in several hours with containment failure likely. More severe consequences if pump trip does fail function
9 Fuel handling accident
Fuel damage accident with release of radioactivity to containment or fuel handling building
Major damage to spent fuel in containment or fuel handling building
10 Control room evacuation
Evacuation of control room anticipated or required with control of shutdown system established from local stations
Evacuation of control room and control of shutdown systems from local stations not established in 15 min
11 Fire
Fire within the plant lasting more than 10 min
Fire potentially affecting safety systems
Fire compromising the functions of safety systems
12 Security threat
Security threat, attempted entry, or attempted sabotage
Ongoing security compromise
Imminent loss of physical control of the plant
Loss of physical control of the facility
13 Natural phenomena and other hazards
Natural phenomena or other hazards being experienced or projected beyond usual levels
Other plant conditions exist that warrant increased awareness on the part of plant operating staff or State and / or local off-site authorities, that require plant shutdown under technical specification requirements, or that involve other than normal controlled shutdown
Severe natural phenomena or other hazards being experienced or projected
Other plant conditions exist that warrant precautionary activation of Technical Support Center and placing near-site Emergency Operations Facility and other key emergency personnel on standby
Severe natural phenomena or other hazards being experienced or projected with plant not in cold shutdown
Other plant conditions warrant activation of emergency centers and monitoring teams or a precautionary notification to the public near the site
Other plant conditions exist, from whatever source, that make release of large amounts of radioactivity in a short time possible (e.g., any core melt situation)

Fig. 1.3. Boiling water reactor (BWR) event tree for emergency classification.

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Some licensees have developed Emergency Action Levels based on the status of the following critical safety functions:

1. keeping the core subcritical,

2. keeping the core cool,

3. keeping the core covered,

4. keeping the integrity of the containment, and

5. controlling any release,

and how these functions relate to the status of the fission product barriers (primary system, cladding, and containment).

Slide 20

Figure 1.4 shows a typical relationship between critical safety functions and classifications.

Slide 21

Table 1.2 shows several examples of the timing of some boiling water reactor (BWR) core damage accidents; these examples illustrate that core damage could occur within a few minutes or many hours. These are only examples to show what might be typical of the timing during an event and to demonstrate how the ability to take early action based on the exceeding of Emergency Action Levels could provide sufficient time to implement protective actions.

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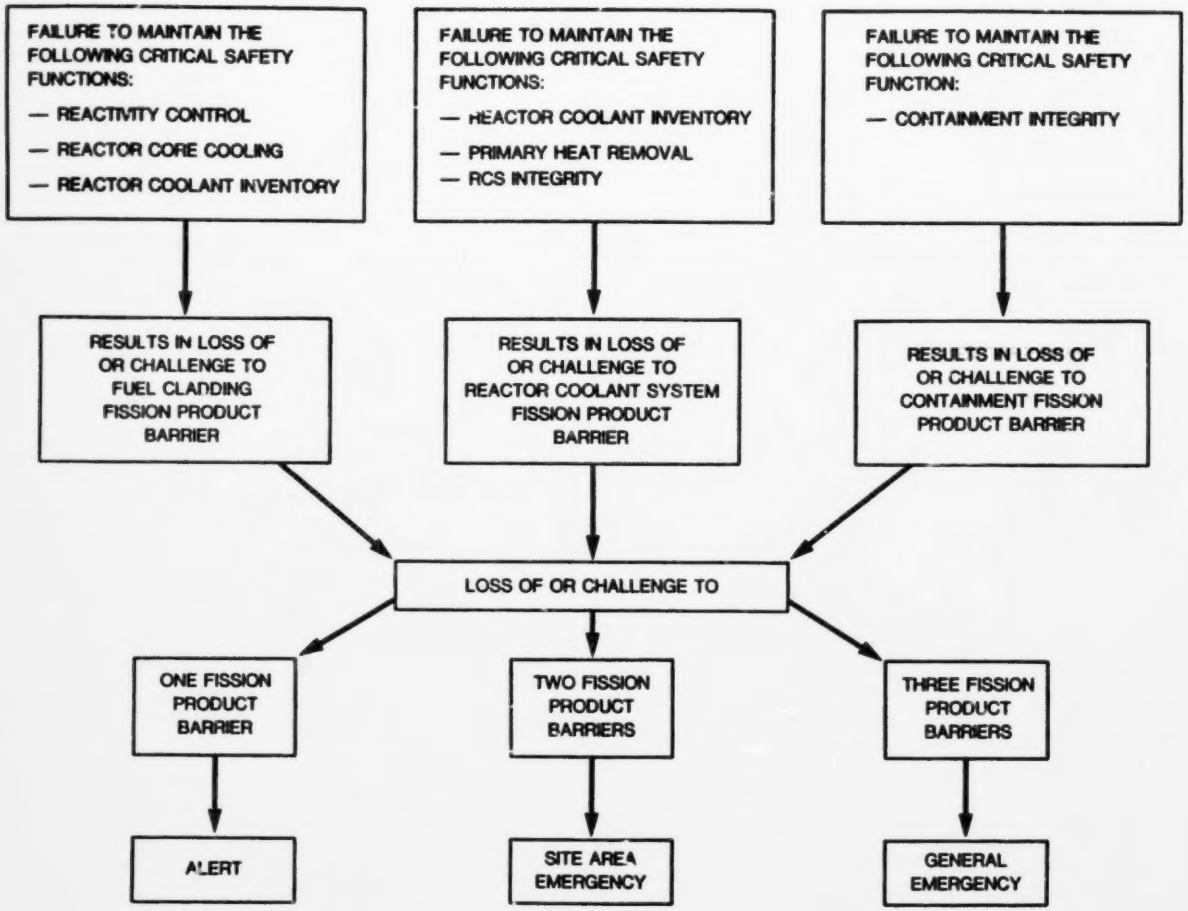
FAILURE TO MAINTAIN THE FOLLOWING CRITICAL SAFETY FUNCTIONS:
— REACTIVITY CONTROL
— REACTOR CORE COOLING
— REACTOR COOLANT INVENTORY
FAILURE TO MAINTAIN THE FOLLOWING CRITICAL SAFETY FUNCTIONS:
— REACTOR COOLANT INVENTORY
— PRIMARY HEAT REMOVAL
— RCS INTEGRITY
FAILURE TO MAINTAIN THE FOLLOWING CRITICAL SAFETY FUNCTION:
— CONTAINMENT INTEGRITY
RESULTS IN LOSS OF OR CHALLENGE TO FUEL CLADDING FISSION PRODUCT BARRIER
RESULTS IN LOSS OF OR CHALLENGE TO REACTOR COOLANT SYSTEM FISSION PRODUCT BARRIER
RESULTS IN LOSS OF OR CHALLENGE TO CONTAINMENT FISSION PRODUCT BARRIER
LOSS OF OR CHALLENGE TO
ONE FISSION PRODUCT BARRIER
TWO FISSION PRODUCT BARRIERS
THREE FISSION PRODUCT BARRIERS
ALERT
SITE AREA EMERGENCY
GENERAL EMERGENCY

Fig. 1.4. Typical relationship among critical safety functions (CSFs), fission product barriers, and classes of emergency.

18

Table 1.2. Example of timing for boiling water reactor (BWR) general emergency sequences

	Timing of event (hr)			
	TW[a]	TQUV[b]	AE[c]	S_2J[d]
Unusual Event	0.017			
Alert	0.333			0.17
Site Area Emergency	1			0.5
General Emergency (protective actions recommended)	1 to 3	0.17	0.17	3+
Core damage	18	1	0.17	29
Containment failure[e]				
Leak	16	3	0.25	
Major	21	5	3	20

[a]Reactor shutdown followed by loss of decay heat removal.

[b]Reactor shutdown followed by loss of ability to provide coolant water.

[c]Large loss of coolant and failure of system to replace water.

[d]Small loss of coolant and loss of long-term heat removal.

[e]Assuming isolation.

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1.7.2 Emergency Class Descriptions

Slides 22 and 23

Each respective class summarized in Table 1.3 requires specific initial actions. The initial actions appropriate for each class are summarized in Table 1.4 and discussed in more detail in the following sections.

1.7.2.1 Unusual Event

Slide 24

The rationale for establishing notification of an "Unusual Event" as an emergency class is to provide early and prompt notification of minor events that could possibly lead to more serious conditions.

The purpose of off-site notification is to

1. ensure that the first step in any response later found to be necessary has been carried out,

2. bring the operating staff to a state of readiness,

3. provide systematic handling of unusual events information and decision making, and

4. control rumors.

1.7.2.2 Alert

Slide 25

Events are in progress or have occurred that involve an actual or potential, substantial degradation of the level of safety at the plant. Any radiological releases are expected to

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Table 1.3. Emergency class descriptions

Class[a]	Core status	Radiation
Unusual Event	No threat to irradiated fuel	No release above technical specifications (or annual limits)
Alert	Actual (or potential for) substantial degradation of safety	Release is small fraction of Environmental Protection Agency (EPA) Protective Action Guides (PAGs) beyond the site boundary
Site Area Emergency	Major failures of functions needed for public protection	Release is less than EPA PAGs beyond the site boundary
General Emergency	Actual or imminent core degradation	Dose may exceed EPA PAGs

[a]Classifications are based on plant instrument levels (i.e., Emergency Action Levels).

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Table 1.4. Emergency class response

Class[a]	Plant action	Local and state agency action
Unusual Event	Provide notification	Be aware
Alert	Mobilize plant resources Man centers (help for control room)	Stand by[a]
	Activate Technical Support Center (TSC)	
Site Area Emergency	Full mobilization Nonessential site personnel evacuate	Mobilize Man emergency centers and dispatch Monitoring Team
	Activate TSC, Operations Support Center, and Emergency Operations Facility	Inform public--activate warning system
	Dispatch Monitoring Team	Take protective actions in accordance with Protective Action Guides or on an ad hoc basis
	Provide dose assessments	
General Emergency	Full mobilization Recommend predetermined protective actions (within 15 min) after declaring emergency	Recommend predetermined protective actions to the public based on plant conditions
		Precautionary evacuation (2 to 5 miles)

[a]The NRC will typically begin staffing its response centers at the Alert level and may be expected to go to "standby" or "initial activation."

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be limited to small fractions of the U.S. Environmental Protection Agency (EPA) Protective Action Guides.

The purpose of an Alert is to

1. ensure that the on-site Technical Support Center is activated so that licensee emergency personnel are readily available to respond,

2. provide off-site authorities with information on the current status of the event, and

3. provide assistance to the control room staff.

1.7.2.3 Site Area Emergency

Slide 26

Events are in progress or have occurred that involve actual or likely major failures of plant functions needed for protection of the public. Any releases are not expected to exceed Environmental Protection Agency Protective Action Guide exposure levels, except possibly near the site boundary.

The purpose of the Site Area Emergency declaration is to

1. ensure that all emergency response centers are manned,

2. ensure that radiological monitoring teams are dispatched,

3. ensure that personnel required to aid in the evacuation of near-site areas are at duty stations should the situation become more serious,

4. provide consultation with off-site authorities,

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5. provide updates for the public through off-site authorities, and

6. ensure that nonessential personnel are evacuated.

1.7.2.4 General Emergency

Slide 27

Events are in progress or have occurred that involve actual or imminent substantial core degradation or melting. Risks of exceeding Environmental Protection Agency Protection Action Guide exposure levels in more than the immediate area are considerably elevated. This is a very special case. A General Emergency indicates that plant conditions are well beyond design and early protective actions are warranted.

The purpose of the General Emergency declaration is to

1. initiate predetermined protective action notification to the public and

2. bring the full available resources of government and industry to bear on the situation.

A summary of emergency classification actions for the three major classes is presented in Table 1.3.

1.7.2.5 Protective Action Recommendations

Slide 28

As discussed earlier, within 15 min of identifying a situation requiring urgent action (General Emergency), the licensee must recommend protective actions to off-site officials. For situations requiring urgent actions, recommended protective actions should have been predetermined based on

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discussions with off-site officials. It is important to realize that they have been developed by the licensee and off-site officials considering plant and local conditions. The basic concepts for public protective action recommendations during severe accidents are discussed in Vol. 4. It is important to note that the specific applications of these concepts are site-specific. For example, one plan may call for initial evacuation out to 5 miles, while another calls for initial evacuation out to 3 miles, but the basic concept of prompt evacuation of the area near the plant for a General Emergency is met.

No predetermined actions are established for site area and lesser events. The specific actions for these lesser events would be based on projected plant conditions, off-site projections, and monitoring conducted at the time.

1.8 EMERGENCY RESPONSE CENTERS AND ORGANIZATIONS

1.8.1 Control Room

Slide 29

Authority to take action in the event of an emergency must reside in the plant control room until the Technical Support Center or the Emergency Operations Facility is activated. This includes the authority to declare emergencies, to notify off-site officials within 15 min of event declaration, and to provide any appropriate protective action recommendations. The NRC must be notified after the appropriate state and local officials are notified and no later than 1 hr after declaring the emergency.

Upon declaration of an emergency, most sites designate an on-site Emergency Director, who is in charge of the plant's total response. During night and week-end hours, this typically is the Shift Supervisor. Once the appropriate augmentation staff arrive following declaration of an emergency, this responsibility (and title) normally transfers to the Technical

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Support Center and then to the Emergency Operations Facility.

1.8.2 Technical Support Center

Slide 30

There were indications from the events at Three Mile Island that numerous personnel in the control room acted to congest and confuse the reactor operators' control room activities. Review of this accident also shows that there existed a lack of reliable technical data and other records on which to base accident recovery decisions. As a result, today licensees are required to establish Technical Support Centers whose staff have access to plant technical information and who are responsible for engineering support of reactor operations during an accident. Personnel in the Technical Support Center must be able both to assist the control room when needed and to diagnose and mitigate an event. Until the Emergency Operations Facility is activated, the Technical Support Center will also perform the functions of the Emergency Operations Facility. The Technical Support Center is located close to the control room inside a protected and shielded area to allow fast access for face-to-face discussions with control room personnel.

1.8.3 Operations Support Center

Slide 31

The establishment of an Operations Support Center (OSC) was introduced to help relieve the influx of shift/operational support personnel in the control room. The function of the Operations Support Center is to provide a place to which shift personnel report to receive further instructions from the operations staff. The Operations Support Center can be a locker room with reliable communications capability to supervisory and decision-making personnel.

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1.8.4 Emergency Operations Facility

Slide 32

Once activated, the Emergency Operations Facility eventually has primary responsibility for the licensee's response to a severe accident situation. The Emergency Operations Facility is an off-site facility. NRC guidance indicates that it should be 10 to 20 miles from the site, but some may be very close to the site (with hardening/shielding or a backup), and others may be far away.

Slide 33

The Emergency Operations Facility is generally where protective action recommendations will be formulated and where the Emergency Director will be located. Space will also be provided for state and local agencies. The Emergency Operations Facility will provide for coordination of on-site actions with those off site, and for carrying out all off-site actions by the licensee (e.g., monitoring, sampling, and dose assessment).

1.8.5 Flow of Authority and Responsibility

Slide 34

The responsibility and authority for licensee actions during a severe nuclear power plant accident start in the control room and then flow out as people arrive to man the Technical Support Center and the Emergency Operations Facility. The licensee will typically start transferring functions/responsibilities/authorities out of the control room as soon as possible so that control room personnel can concentrate on bringing the situation under control. The times when the transfers occur generally require 30 min to staff the Technical Support Center and 1 hr to staff the Emergency

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Operations Facility. When NRC staff begin trying to contact licensee personnel, the NRC staff must be aware of how long the accident has been under way to determine where their contacts should be made. The Emergency Network System (ENS) and Health Physics Network (HPN) lines can be used to determine where the appropriate licensee representative is located.

1.9 RADIOLOGICAL ASSESSMENT CAPABILITIES

Slide 35

Licensees have established the following capabilities to quantify any radiological release from the core or to the environment:

1. increased effluent monitor coverage and range,
2. postaccident sampling of primary coolant and the containment atmosphere,
3. sampling and analysis of plant effluents, and
4. field monitoring.

The role and usefulness of radiological assessment capabilities are discussed in Vol. 2.

1.9.1 Increased Effluent Monitor Coverage and Range

Slide 36

During the Three Mile Island accident, several of the radiation monitors designed to assess releases were off scale and some pathways were not monitored. As a result, licensees have been required to install monitors on expected release pathways such as building exhausts, condenser exhausts, off-gas

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systems, pressurized water reactor steam system valve discharges, and radwaste buildings and storage buildings.

In addition, requirements for the range of the instrumentation have been established at a level so that the instruments should stay on scale during the full course of an accident (e.g., 10^7 R/hr for the containment monitor). The probability of monitor bypass or malfunction in accident environments (as discussed in Vol. 2) must not be ruled out.

1.9.2 Postaccident Sampling

Slide 37

As a result of lessons learned from Three Mile Island and other experiences, licensees have been required to install postaccident sampling and analysis facilities with the capability to quantify within 3 hr radionuclide indicators of the degree of core damage (e.g., noble gases, cesium, and iodine) (these indicate cladding failure) and nonvolatile isotopes (these indicate fuel melting). In addition, chemical analysis must also be established to quantify hydrogen levels in the containment atmosphere and boron concentrations in the primary coolant. These systems must allow sampling with exposure of less than 5 rem (whole body) under accident conditions.

1.9.3 Sampling and Analysis of Plant Effluents

Because iodine gaseous effluent monitors for accident conditions are not considered to be practical, licensees have installed the capability for effluent sampling of radioiodine under accident conditions without excess (5 rem whole-body) exposures. These samples are designed to quantify the iodine and other non-noble-gas releases from the plant by monitored pathways. Since these samples are taken after the release, they will be useful in characterizing a major release once it is

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underway.

1.9.4 Field Monitoring

As discussed in Vol. 2, field monitoring and sampling provide the only direct measurements of off-site doses. Typically, the licensees have made provisions to monitor the site boundary shortly after a release. Additional field-monitoring teams in the plume Emergency Planning Zone will be deployed in about an hour. The difficulties associated with field monitoring are discussed in Vol. 2. However, monitoring does provide a true indication of off-site doses and should replace dose projections as soon as sufficient results are available.

1.10 MAJOR POINTS

Slide 38

The major points covered in this section are summarized as follows.

- The licensee and state and local officials are responsible for taking immediate actions--not the NRC. The NRC should interfere only if there is a serious lack of appropriate action. In such a case, the NRC should attempt to determine the reason for a problem.

- When prompt protective action is dictated by plant conditions in a serious accident, it is not appropriate to call NRC for concurrence in that action prior to initiating implementation.

- The plume Emergency Planning Zone is the area for which extensive preplanning has been done. The actual shape and area of the Emergency Planning Zone (about 10 miles in

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radius) are site specific.

- Licensees have in place Emergency Operating Procedures that will direct their response to correct a problem with the plant.

- Specific immediate appropriate actions are preplanned for each class of accidents.

- Licensees have in place instrumentation, procedures, and training for detection of inadequate core cooling and core damage.

- Accidents are classified based on observeable initiating conditions (Emergency Action Levels).

- The General Emergency class should initiate recommendation and subsequent implementation of predetermined protective actions off site.

- The licensee authority and responsibility for taking actions on site (e.g., notifying and making recommendations to off-site officials) will initially be in the control room, but as other personnel arrive, authority and responsibility for certain actions will move to the Technical Support Center (accident assessment) and Emergency Operations Facility (dose projection and off-site coordination).

- As a result of lessons learned from Three Mile Island, licensees have installed and improved effluent monitoring and postaccident sampling capabilities.

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2. RESPONSE OF STATE AND LOCAL ORGANIZATIONS

2.1 OBJECTIVES

Slide 39

Following completion of this section, the student should be able to

- state where the responsibility for protective action decisions resides,
- describe the provisions for and timing of public notification of the plume Emergency Planning Zone (EPZ) population,
- describe the criteria that should be used in making decisions and how the criteria are adjusted to local conditions,
- describe the role and shortcomings of evacuation time estimates,
- describe state and local radiological monitoring capabilities, and
- state why it is <u>not</u> acceptable for protective action to be based solely on U.S. Environmental Protection Agency (EPA) Protective Action Guides (PAGs) and dose projections.

2.2 EMERGENCY RESPONSE PLANS

States and local agencies have formulated written emergency response plans in response to U.S. Nuclear Regulatory Commission (NRC) and Federal Emergency Management Agency (FEMA) requirements. These documents (1) describe the procedures that

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state and local officials will follow in the event of a nuclear power plant emergency and (2) list the responsibilities of each state and local agency involved.

2.3 DELINEATION OF RESPONSIBILITY

Slide 40

Since the authority to implement public protective actions may reside with local or state officials, the NRC must determine who has this authority before making any recommendations. This information is available in the appropriate state and local emergency plans.

2.4 PROTECTIVE ACTIONS AND NOTIFICATION OF PUBLIC

Slide 41

The licensee must notify off-site state and local organizations responsible for implementing protective actions within 15 min of the declaration of an emergency. This permits off-site officials to make prompt protective action decisions and to (1) provide an alerting signal (e.g., a siren) and (2) follow the signal by a message via the local radio station as to what actions the public should take. State and local officials have predetermined the criteria that they will use to make protective action decisions. These criteria should have been coordinated with the recommendations made to local agencies by the licensee. Any protective action decisions should be based on actual plant conditions (see Sect. 1.7).

In most cases, the specific protective action criteria for General Emergencies have been developed after consideration of plant and local conditions. For example, the areas planned to be evacuated may be confined to a valley around the site, or the specific evacuation sector boundaries may be determined by local roads. This delineation is done so that the local population

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can understand the evacuation instructions.

Current guidance (see Vol. 4) calls for prompt off-site protective actions on detection of actual or imminent core damage (before dose assessment). However, many local and state agencies may rely primarily on projected dose. If this is the case, the need for decisions based on core conditions should be discussed by the licensee with state and local officials.

Slide 42

A flow chart showing the typical steps from detection of an event in the power plant control room (CR) to notification of the public is shown in Fig. 2.1. Note that the off-site officials generally make decisions based on licensee recommendations, which are, in turn, based on criteria discussed and agreed to in advance. However, only off-site authorities know what off-site conditions actually exist at the time the event is occurring (e.g., ice storm, blocked highway, bridge out, etc.) that might alter implementation of the licensee's recommendation.

2.5 EVACUATION TIME ESTIMATES

Slide 43

Licensees were required to develop evacuation time estimates for the full-plume Emergency Planning Zone (10-mile radius). These estimates were based on various models and must be used with caution. These models have not been validated against evacuations and may be subject to great uncertainties.

Often, the evacuation time estimates are dominated by assumptions of how long it will take to notify people and for them to get ready to leave. Sometimes it is assumed that it will take an hour or more for preevacuation preparation. Actual experience has shown, however, that, if people are told and motivated to "go now," most will follow instructions, and most

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EVENT DETECTED BY CONTROL ROOM STAFF
EVENT IS CLASSIFIED, AND EMERGENCY IS DECLARED
OFF-SITE OFFICIALS NOTIFIED ABOUT RECOMMENDATIONS OF PROTECTIVE ACTION
OFF-SITE OFFICIALS DECIDE ON ACTIONS TO BE TAKEN
SIRENS SOUND, AND THE PUBLIC TUNES TO LOCAL RADIO STATION
RADIO MESSAGE ADVISES TO EVACUATE AS SOON AS POSSIBLE
INDIVIDUALS LEAVE HOMES

Fig. 2.1. Flow chart showing steps from detection of an event in the control room to notification of the public.

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will evacuate very fast. Except for special cases where there is a large population near the site (i.e., Zion and Indian Point) or where there is some special population (e.g., hospital patients), the area near the site should be able to be evacuated in 1 hr or less. Because of the NRC's siting criteria, there is a limited population (<300 people) within 2 miles of most sites. In these cases, the capacity of the local roads will be great enough so as not to delay an evacuation.

2.6 DOSE PROJECTIONS AND FIELD MONITORING

Slide 44

Dose projection models used by off-site officials are generally similar to those used by the licensee and have the same limitations as other dose models. The only source of release estimates (source term) is from the licensee. Therefore, while off-site officials can confirm (check) licensee transport calculations, they must rely on the licensee's release (source term) estimates. Because of the complex processes involved in a core melt scenario, the source term (release) estimate will provide the greatest source of uncertainty early in an event. The degree of off-site monitoring capabilities varies markedly from excellent to marginal, depending on the state's emphasis on developing an independent capability. In some situations, off-site officials rely on the licensee or the responding federal agencies [e.g., U.S. Department of Energy (DOE), Environmental Protection Agency, and NRC] for monitoring information.

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2.7 LOCATION OF AUTHORITY AND RESPONSIBILITY

Slide 45

During the initial phase of the event, the specific location of the local off-site officials with the authority and responsibility to take action varies. The communications system between the licensee and off-site officials should accommodate this need. This is very site- and/or state-specific. In some cases, there are duty officers and 24-hr manned centers, and in others there are local police stations. Once the local emergency organization has been activated, it will establish a local Operations Center. It should be noted that at some sites there are several (2 to 20) local governments within the plume Emergency Planning Zone and that each might have a center.

At the state level, there are typically two levels of activity of interest: (1) an organization that is responsible for conducting technical assessments (e.g., dose assessment) of the situation and (2) decision makers (e.g., governor). These functions may be performed at two separate locations (centers). The NRC must coordinate its contact with off-site officials to avoid considerable confusion resulting from carrying out discussions with both groups. (See Vol. 5 for a discussion of the interfaces with these two levels of state response.) The licensee or state emergency plans should be consulted to determine the specific emergency organization's locations.

2.8 MAJOR POINTS

Slide 46

The major points covered in this section are summarized as follows.

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- The off-site officials responsible for taking protective actions must be identified early in an event for the appropriate NRC interface.

- State and local dose projection methods are, in most cases, similar to the methods used by the licensee and NRC and have the same relative uncertainty.

- Provisions exist in the vicinity of all reactor sites for promptly notifying the public living within the plume Emergency Planning Zone.

- Evacuation time estimates should be used with great caution. Often they apply to the full Emergency Planning Zone rather than to the nearby low-population zone.

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Appendix A

SLIDES RELATING TO VOLUME 3 OF THE SEVERE REACTOR ACCIDENT INCIDENT RESPONCE TRAINING MANUAL

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APPENDIX A

SLIDES RELATING TO SEVERE REACTOR ACCIDENT INCIDENT RESPONSE TRAINING MANUAL:

RESPONSE OF LICENSEE AND STATE AND LOCAL OFFICIALS

VOL. 3
NUREG-1210
ORNL/TM-9271/V3

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Slide 1

OBJECTIVES

- Describe the responsibilities of the licensee during an accident
- Describe what preparations have been made in the plume emergency planning zone (EPZ) and describe a typical EPZ boundary
- Describe the four classes of emergencies and, in general, the action taken by the licensee and off-site officials for each
- Describe how events are classified and the basis for these classification systems [Emergency Action Levels (EALs)]
- Describe the function of the Control Room, Technical Support Center (TSC), and Emergency Operations Facility (EOF) during an event and how responsibility flows from one to the other
- Describe the licensee's accident assessment monitoring and dose assessment capabilities

Slide 2

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REGULATORY BASES FOR LICENSEE PLANS

- NUREG 0396
- NUREG 1131
- Information Notice 83-28
- 10 CFR 50.47 and Appendix E
- NUREG 0654 (Regulatory Guide 1.101, Rev. 2)
- NUREG 0737, Supplement 1

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Slide 3

45

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EMERGENCY PREPAREDNESS REQUIREMENTS AFFECTING NRC'S ROLE OF MONITORING PROTECTIVE ACTIONS

- Event detection and classification
- Emergency Planning Zone (EPZ)
- Radiological monitoring and dose assessment
- Emergency organizations and response centers

Slide 4

NRC ROLE IN AN EMERGENCY

- Monitor
- Provide assistance
- Keep informed

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Slide 5

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RESPONSIBILITIES OF LICENSEES

- Control the accident
  - Protect the core
  - Control the release
- Notify off-site officials within 15 min of emergency declaration and, if necessary, recommend protective actions

Slide 6

RESPONSIBILITIES OF STATE AND LOCAL AGENCIES

- Protect the public from the off-site consequences of an accident
- Decide when to notify the public
- Decide what protective measures for the public are needed (e.g., sheltering or evacuation)
- Notify the public in the event of a severe accident

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Slide 7

BASES FOR SIZE OF PLUME EXPOSURE EPZs

- Projected doses from design basis accidents and from most core-melt sequences would not exceed upper-level Environmental Protection Agency (EPA) Protective Action Guides (PAGs) within zone
- Immediate life-threatening doses for the worst-case core melt sequences would not occur outside this zone
- Plume EPZ provides a basis for expansion of response efforts if necessary

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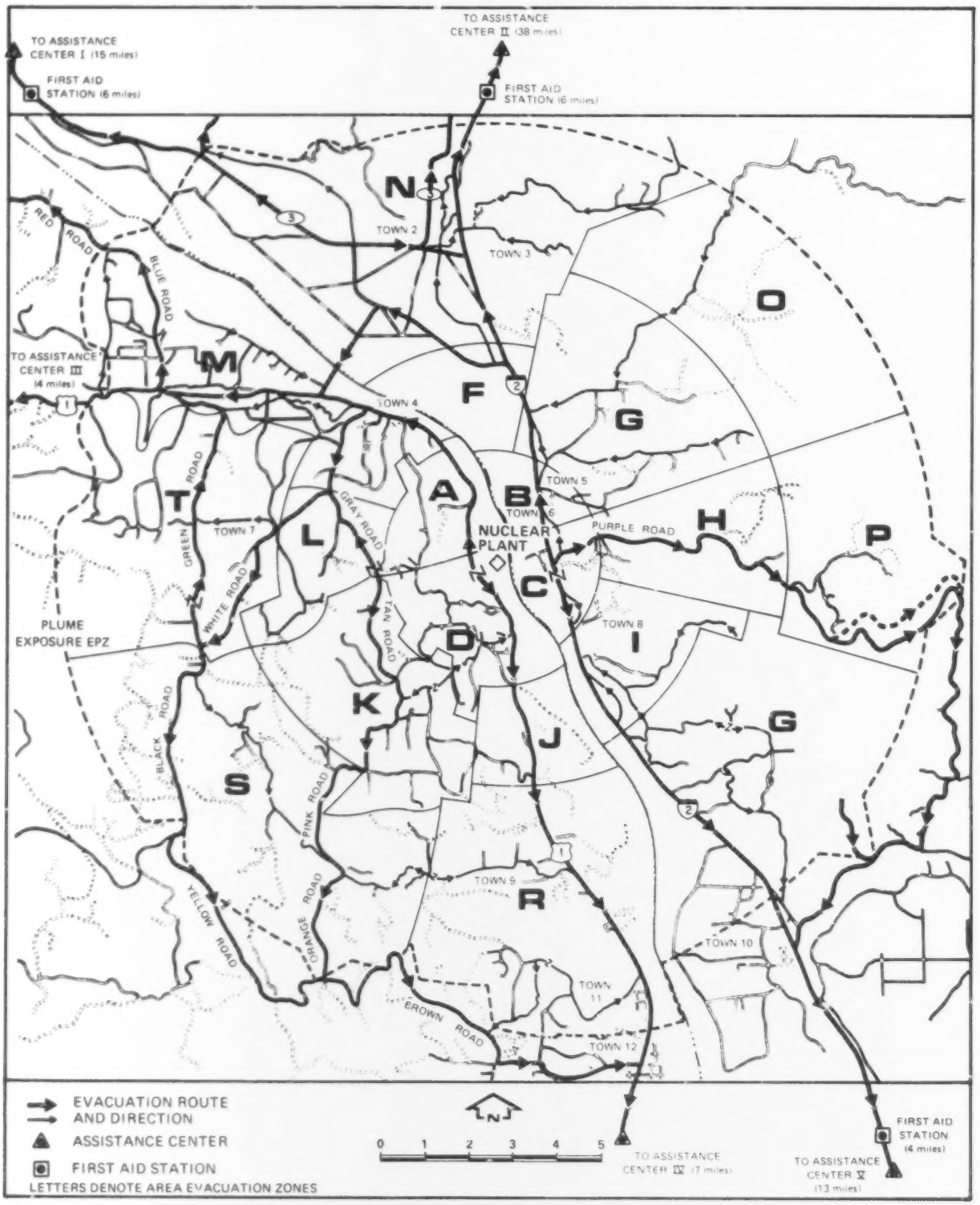
EXAMPLE OF A PLUME EMERGENCY PLANNING ZONE (BOUNDARIES AND EVACUATION ROUTES ARE DETERMINED BY ROADS)



Slide 9

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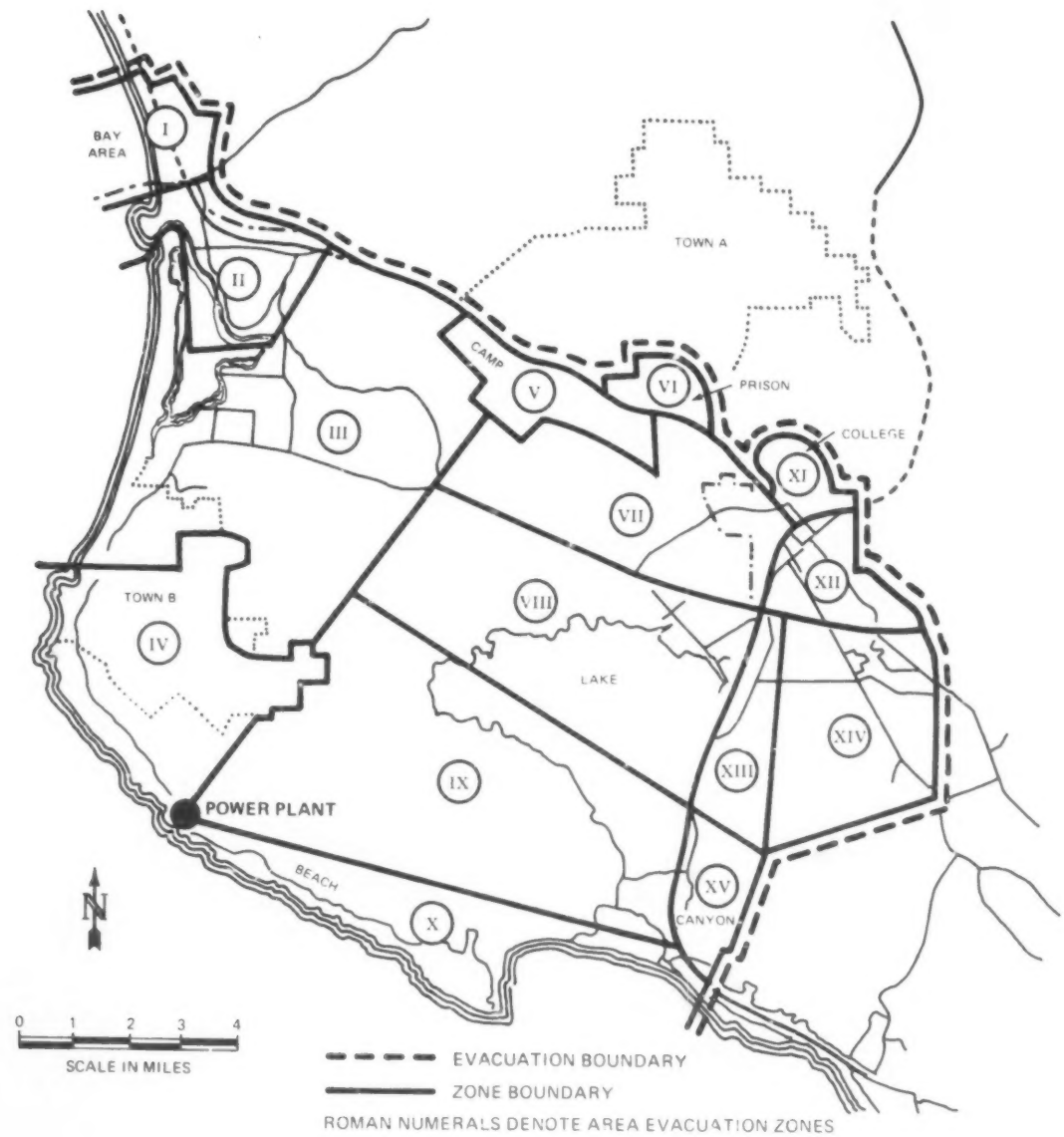
EXAMPLE OF A PLUME EMERGENCY PLANNING ZONE (BOUNDARIES ARE DETERMINED BY NATURAL FEATURES)



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OFF-SITE PLANS FOR THE PLUME EXPOSURE PATHWAY ADDRESS

- Prompt decision making by off-site officials concerning protective actions for the public
- Development of evacuation plans
- Means to inform the public of emergency plans and procedures
- Means for promptly alerting and informing the public of actions to take (e.g., siren system and radio messages)
- Means of maintaining 24-hr communication between licensee and off-site officials
- Provisions for radiological monitoring
- Provisions for activating and maintaining emergency operations centers

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Slide 11

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INGESTION PATHWAY EPZ

- Approximately 50-mile radius
- Concern is with interdiction of foodstuffs
- More time is available for responders to take action
- Decisions on actions to take are usually made at the state level

Slide 12

BASES FOR SIZE OF INGESTION PATHWAY EPZs

- Downwind range where contamination will generally not exceed EPA PAGs within zone
- Iodine may be converted into forms not readily available for incorporation into foodstuffs
- Virtually all particulates would be deposited within 50 miles

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Slide 13

EMERGENCY OPERATING PROCEDURES

- Before TMI-2, control room procedures for analyzing problems were limited to certain predetermined events
- After TMI-2, licensees were required to prepare symptom-oriented procedures
- Limits analysis to a few critical safety functions (CSFs), which result in "safe" conditions for the plant
- Actions are based on plant/control room instrument readings
- Procedures generally do not address actions to be taken after core damage

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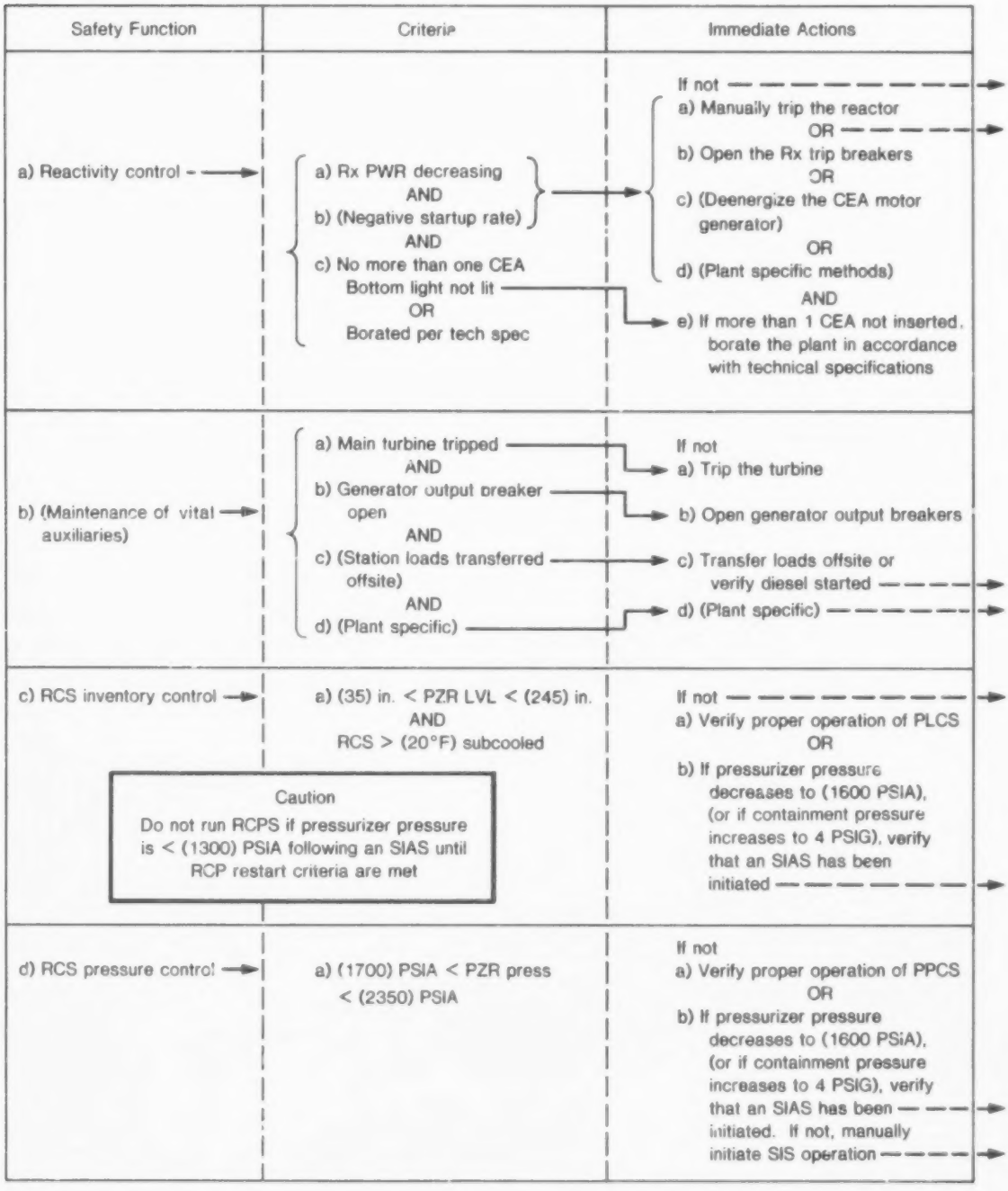
EXAMPLE OF IMMEDIATE ACTIONS TO ASSESS SAFETY FUNCTIONS


Safety Function
Criteria
Immediate Actions
a) Reactivity control
a) Rx PWR decreasing
AND
b) (Negative startup rate)
AND
c) No more than one CEA
Bottom light not lit
OR
Borated per tech spec
If not
a) Manually trip the reactor
OR
b) Open the Rx trip breakers
OR
c) (Deenergize the CEA motor generator)
OR
d) (Plant specific methods)
AND
e) If more than 1 CEA not inserted, borate the plant in accordance with technical specifications
b) (Maintenance of vital auxiliaries)
a) Main turbine tripped
AND
b) Generator output breaker open
AND
c) (Station loads transferred offsite)
AND
d) (Plant specific)
If not
a) Trip the turbine
b) Open generator output breakers
c) Transfer loads offsite or verify diesel started
d) (Plant specific)
c) RCS inventory control
a) (35) in. < PZR LVL < (245) in.
AND
RCS > (20°F) subcooled
Caution
Do not run RCPS if pressurizer pressure is < (1300) PSIA following an SIAS until RCP restart criteria are met
If not
a) Verify proper operation of PLCS
OR
b) If pressurizer pressure decreases to (1600 PSIA), (or if containment pressure increases to 4 PSIG), verify that an SIAS has been initiated
d) RCS pressure control
a) (1700) PSIA < PZR press < (2350) PSIA
If not
a) Verify proper operation of PPCS
OR
b) If pressurizer pressure decreases to (1600 PSIA), (or if containment pressure increases to 4 PSIG), verify that an SIAS has been initiated. If not, manually initiate SIS operation

Slide 15

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CORE CONDITION ASSESSMENT

- Instrumentation to detect and assess inadequate core cooling and damage
- Procedures
- Operator training

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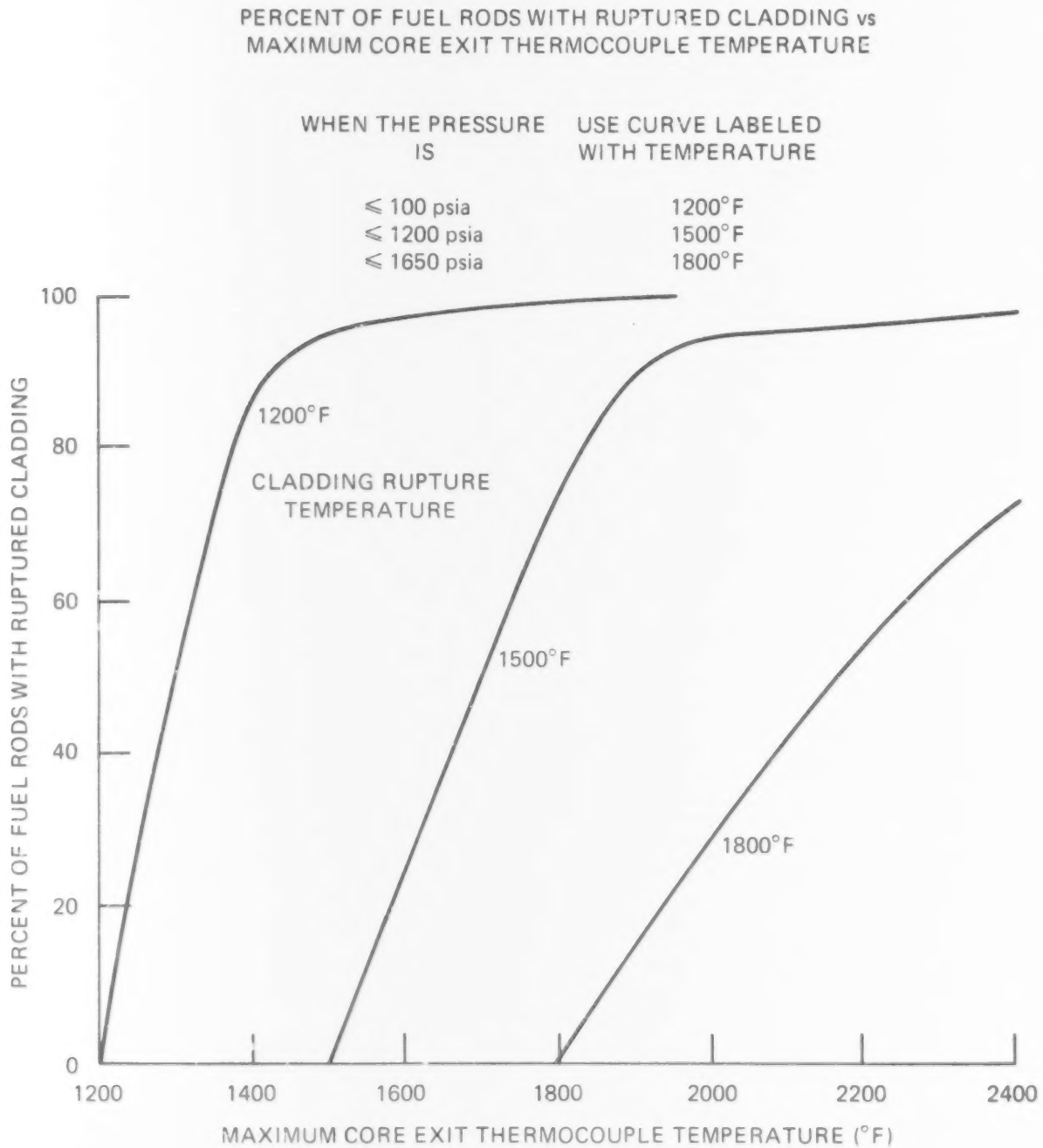
THERMOCOUPLE TEMPERATURE vs CORE DAMAGE



Slide 17

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EMERGENCY ACTION LEVELS

- Measurable/observable control room instrument readings (e.g., 1000 R/hr containment monitor, 2000°F thermocouple)
- Trigger level for declaration of emergencies, activation of emergency organization, and protective action decisions
- Each licensee plan contains EALs
- Most EALs are based on NUREG 0654 guidance
- To deal with the many parameters of concern, many licensees use flow charts and visual aids

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SAMPLE EALs FOR ONE INITIATING CONDITION

Initiating Condition No. 1	EALs
Known loss of coolant accident greater than makeup pump capacity	Low reactor water level (−134 in.) on level/pressure recorder 1B21-R623B, panel 1H12-P601 OR High drywell pressure (+1.8 lb) on pressure indicators CM010 and/or CM021, panel 1PM06J WITH Water level below (and failure to return to) top of active fuel as indicated on fuel zone level indicator 1B21-R6210, panel 1H13-P601 (−150 in. +50 in. range with "0" corresponding to top of active fuel), following a time delay of 3 min

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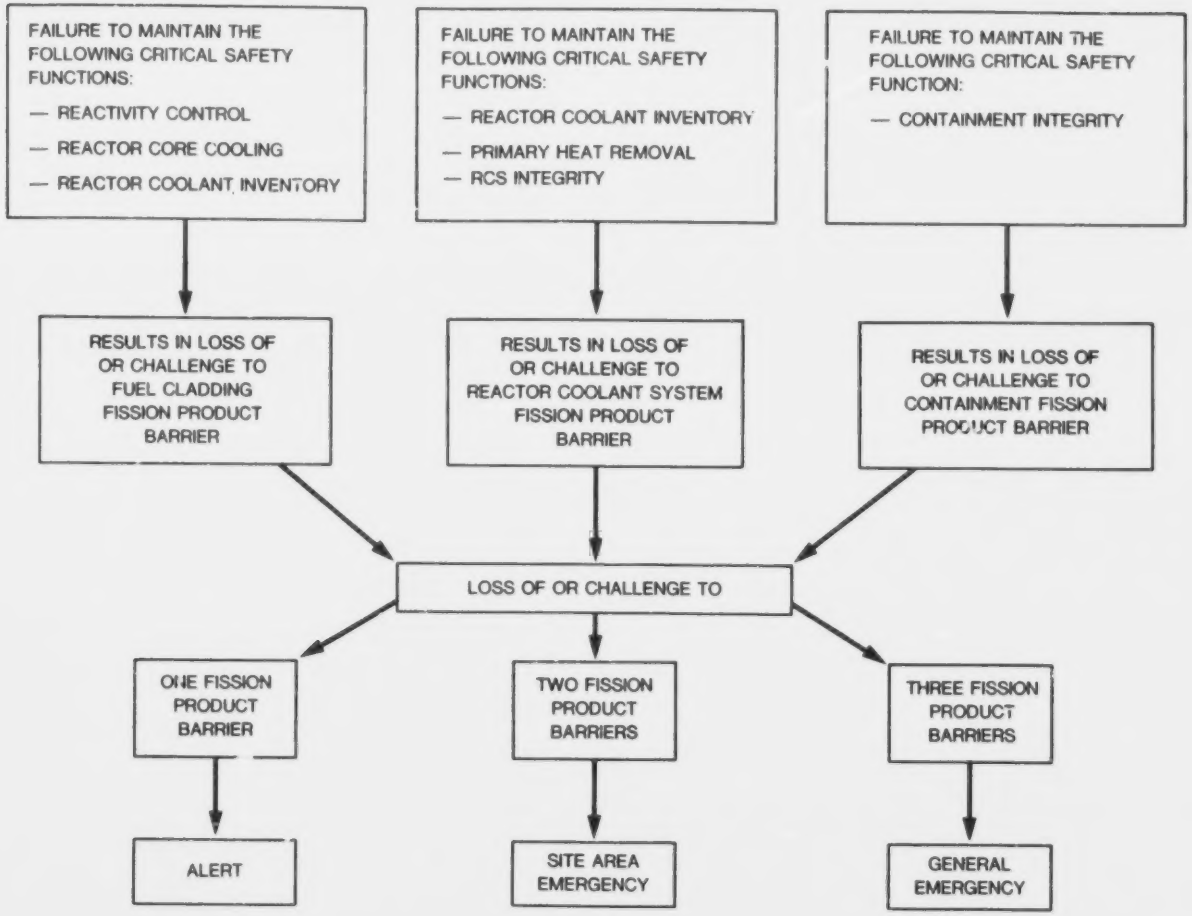
TYPICAL RELATIONSHIP AMONG CRITICAL SAFETY FUNCTIONS, FISSION PRODUCT BARRIERS, AND CLASSES OF EMERGENCY


FAILURE TO MAINTAIN THE FOLLOWING CRITICAL SAFETY FUNCTIONS:
— REACTIVITY CONTROL
— REACTOR CORE COOLING
— REACTOR COOLANT INVENTORY
FAILURE TO MAINTAIN THE FOLLOWING CRITICAL SAFETY FUNCTIONS:
— REACTOR COOLANT INVENTORY
— PRIMARY HEAT REMOVAL
— RCS INTEGRITY
FAILURE TO MAINTAIN THE FOLLOWING CRITICAL SAFETY FUNCTION:
— CONTAINMENT INTEGRITY
RESULTS IN LOSS OF OR CHALLENGE TO FUEL CLADDING FISSION PRODUCT BARRIER
RESULTS IN LOSS OF OR CHALLENGE TO REACTOR COOLANT SYSTEM FISSION PRODUCT BARRIER
RESULTS IN LOSS OF OR CHALLENGE TO CONTAINMENT FISSION PRODUCT BARRIER
LOSS OF OR CHALLENGE TO
ONE FISSION PRODUCT BARRIER
TWO FISSION PRODUCT BARRIERS
THREE FISSION PRODUCT BARRIERS
ALERT
SITE AREA EMERGENCY
GENERAL EMERGENCY

Slide 20

62

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EXAMPLE OF TIMING FOR BOILING WATER REACTOR GENERAL EMERGENCY SEQUENCES

	Timing of Event (hr)			
	TW[a]	TQUV[b]	AE[c]	S_2J[d]
Unusual Event	0.017			
Alert	0.333			0.17
Site Area Emergency	1			0.5
General Emergency (protective actions recommended)	1 to 3	0.17	0.17	3+
Core Damage	18	1	0.17	29
Containment Failure[e]				
Leak	16	3	0.25	
Major	21	5	3	20

[a]Reactor shutdown followed by loss of decay heat removal.

[b]Reactor shutdown followed by loss of ability to provide coolant water.

[c]Large loss of coolant and failure of system to replace water.

[d]Small loss of coolant and loss of long-term heat removal.

[e]Assuming isolation.

Slide 21

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EMERGENCY CLASS DESCRIPTIONS

Class[a]	Core Status	Radiation
Unusual Event	No threat to irradiated fuel	No release above technical specifications (or annual limits)
Alert	Actual (or potential for) substantial degradation of safety	Release is small fraction of EPA PAGs beyond the site boundary
Site Area Emergency	Major failures of functions needed for public protection	Release is less than EPA PAGs beyond the site boundary
General Emergency	Actual or imminent core degradation	Dose may exceed EPA PAGs

[a]Classifications are based on plant instrument levels (i.e., EALs).

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Slide 22

EMERGENCY CLASS RESPONSE

Class	Plant Action	Local and State Agency Action
Unusual Event	Provide notification	Be aware
Alert	Mobilize plant resources Man centers (help for control room) Activate Technical Support Center (TSC)	Stand by[a]
Site Area Emergency	Full mobilization Nonessential site personnel evacuate Activate TSC, Operations Support Center, and Emergency Operations Facility Dispatch Monitoring Team Provide dose assessments	Mobilize Man emergency centers and dispatch monitoring team Inform public — activate warning system Take protective actions in accordance with PAGs or on an ad hoc basis
General Emergency	Full mobilization Recommend predetermined protective actions (within 15 min) after declaring emergency	Recommend predetermined protective actions to the public based on plant conditions Precautionary evacuation (2 to 5 miles)

[a]The NRC will typically activate its response centers at the Alert level.

Slide 23

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UNUSUAL EVENT

- Purpose is to
  1. Ensure that the first step in any response later found to be necessary has been carried out
  2. Bring the operating staff to a state of readiness
  3. Provide systematic handling of unusual events information and decision making
  4. Control rumors

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ALERT

- Purpose is to
  1. Ensure that the on-site TSC is activated so that licensee emergency personnel are readily available to respond
  2. Provide off-site authorities with information on the current status of the event
  3. Provide assistance to the control room staff

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SITE AREA EMERGENCY

- Purpose is to
  1. Ensure that all emergency response centers are manned
  2. Ensure that radiological monitoring teams are dispatched
  3. Ensure that personnel required for evacuation of near-site areas are at duty stations should the situation become more serious
  4. Provide consultation with off-site authorities
  5. Provide updates for the public through off-site authorities
  6. Evacuate nonessential plant personnel

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GENERAL EMERGENCY

- Purpose is to
  1. Initiate *predetermined* protective action notification of the public
  2. Bring the full available resources of government and industry to bear on the situation

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Slide 27

69

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PROTECTIVE ACTION RECOMMENDATIONS

- Licensees are required to make a PAR within 15 min of declaring a general emergency
- Protective actions have been preplanned and are generally site-specific
- No predetermined actions are established for the other emergency classes

70

CONTROL ROOM

- Control room is the initial emergency response center
- Control room personnel have 24-hr authority and responsibility to declare an emergency and to recommend protective actions
- Shift supervisor is routinely designated as the emergency director
- During night and weekend hours, it may take up to 1 hr before augmentation arrives

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TECHNICAL SUPPORT CENTER

- Licensees are required to maintain a TSC for assisting the control room staff in diagnosing plant conditions
- The TSC is located close enough to the control room to allow fast access
- The TSC is shielded and has sufficient protection equipment to enable plant staff to work under accident conditions

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Slide 30

72

OPERATIONS SUPPORT CENTER

- Used by shift personnel (e.g., operators and health physics technicians) for supporting the emergency response
- Keeps excess people out of the control room

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Slide 31

EMERGENCY OPERATIONS FACILITY

- Off-site facility for interacting with state and local officials
- Located within 10 to 20 miles of the site
- Space is provided for off-site officials
- Licensee will generally formulate PARs and monitor environmental monitoring teams from the EOF

Slide 32

74

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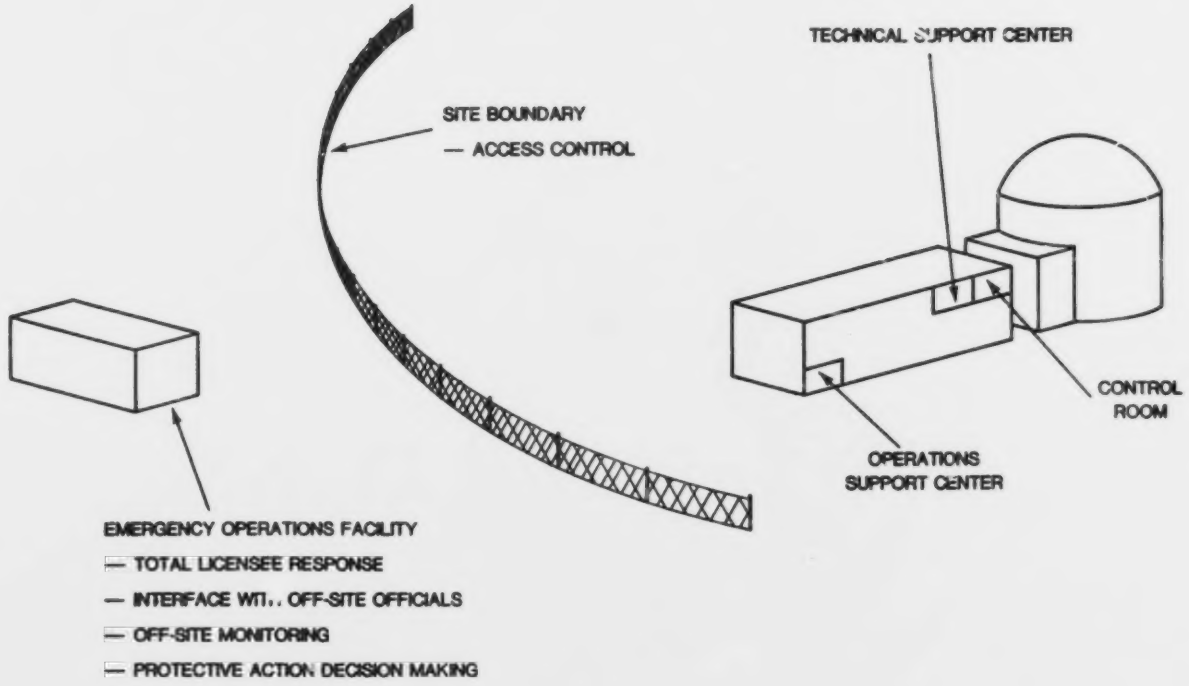
RELATIVE LOCATIONS OF LICENSEE CENTERS



Slide 33

75

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TRANSFER OF AUTHORITY AND RESPONSIBILITY

- Initially all responsibility is in the control room
- All activities that can be moved should be transferred to the TSC as soon as it is staffed
- Usually within 1 hr the EOF will assume responsibility for protective action decision making and total licensee response
- Locate the appropriate NRC interface over the Emergency Notification System or the Health Physics Network

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RADIOLOGICAL ASSESSMENT CAPABILITIES

- Increased effluent monitor coverage and range
- Postaccident sampling
- Effluent sampling
- Field monitoring

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77

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EFFLUENT MONITOR

- On expected release pathways
- On scale for course of accident

Slide 36

REQUIREMENTS FOR POSTACCIDENT SAMPLING

- 3-hr analysis
- Indications of the degree of core damage
- Containment atmosphere (hydrogen)
- Primary coolant (boron and chlorides)

Slide 37

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79

MAJOR POINTS

- The licensee and state and local officials are responsible for taking immediate actions – *not* the NRC. The NRC should interfere only if there is a *serious* lack of appropriate action. In such a case, the NRC should attempt to determine the reason for a problem
- When prompt action is required, NRC concurrence is not appropriate prior to implementation
- The plume EPZ is the area for which extensive preplanning has been done. The actual shape and area of the EPZ (about 10 miles in radius) are site specific
- Licensees have in place EOPs that will direct the response to correct a problem with the plant
- Specific immediate appropriate actions are preplanned for each class of accidents

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Slide 38

MAJOR POINTS (CONTINUED)

- Licensees have in place instrumentation, procedures, and training for detection of inadequate core cooling and core damage
- Accidents are classified based on observables (EALs)
- Declaration of a general emergency should initiate recommendation of predetermined protective actions off site
- The licensee authority and responsibility for taking actions on site will initially be in the control room, but as other personnel arrive, authority and responsibility will move to the TSC (plant assessment) or EOF (dose assessment and off-site coordination)
- As a result of lessons learned from TMI-2, licensees have installed and improved effluent monitoring and postaccident sampling capabilities

Slide 38 (Continued)

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81

OBJECTIVES

- State where the responsibility for protective action decisions resides
- Describe provisions for and timing of public notification of the plume EPZ population
- Describe criteria that should be used in making decisions and how the criteria are adjusted to local conditions
- Describe the role and shortcomings of evacuation time estimates
- Describe state and local radiological monitoring capabilities
- State why it is *not* acceptable for protective action to be based solely on EPA PAGs and dose projections

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Slide 39

DELINEATION OF RESPONSIBILITY

- Determine who has authority
- Information should be available in emergency plans

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PUBLIC NOTIFICATION

- Off-site officials are promptly notified by the licensee to enable them to make prompt protective action decisions
- Once a decision is made, the public will be promptly alerted and advised as to what protective actions to take

Slide 41

EVENT FLOW CHART

EVENT DETECTED BY CONTROL ROOM STAFF
EVENT IS CLASSIFIED, AND EMERGENCY IS DECLARED
OFF-SITE OFFICIALS NOTIFIED ABOUT RECOMMENDATIONS OF PROTECTIVE ACTION
OFF-SITE OFFICIALS DECIDE ON ACTIONS TO BE TAKEN
SIRENS SOUND, AND THE PUBLIC TUNES TO LOCAL RADIO STATION
RADIO MESSAGE ADVISES TO EVACUATE AS SOON AS POSSIBLE
INDIVIDUALS LEAVE HOMES

Slide 42

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EVACUATION TIME ESTIMATES

- Licensees have developed estimates using models that have not been tested and thus must be used with caution
- Because of NRC siting criteria, population within 2 miles of most sites is limited, so evacuation of the area near the plant would involve little delay
- Except for a few cases, the area near the site could be evacuated in 1 hr or less

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Slide 43

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DOSE PROJECTIONS AND FIELD MONITORING

- Off-site officials must rely on the licensee for release estimates in performing dose projections
- Some states have excellent field monitoring capabilities; others rely on licensee or other (i.e., Federal) agencies

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Slide 44

LOCATION OF AUTHORITY AND RESPONSIBILITY

- A licensee's communication of an emergency with off-site officials is frequently via local or state police
- Off-site officials will generally staff one emergency operations center but may have many – one for each town
- States frequently have two levels of interest: technical and decision-making. The NRC contact must recognize the role of each level

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Slide 45

MAJOR POINTS

- The off-site officials responsible for taking protective actions must be identified
- Not all state/local plans calls for taking actions based on plant conditions (i.e., before an actual release occurs)
- State and local dose projection methods are, in most cases, similar to the methods used by the licensee and NRC (i.e., very uncertain)
- In the vicinity of all reactor sites, provisions exist for promptly notifying the public living within the plume EPZ
- Evacuation time estimates should be used with great caution. Often they apply to the full EPZ rather than to the nearby low-population zone

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NRC FORM 335 (2-84) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

SEE INSTRUCTIONS ON THE REVERSE

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Vol. 3

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Response of Licensee and State and Local Officials

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12 SUPPLEMENTARY NOTES

13 ABSTRACT (200 words or less)

This is one in a series of volumes that collectively provide for the U.S. Nuclear Regulatory Commission (NRC) emergency response personnel the necessary background information for an adequate response to severe reactor accidents. The volumes in the series are:

- Volume 1 -- Overview and Summary of Major Points
- Volume 2 -- Severe Reactor Accident Overview
- Volume 3 -- Response of Licensee and State and Local Officials
- Volume 4 -- Public Protective Actions -- Predetermined Criteria and Initial Actions
- Volume 5 -- U.S. Nuclear Regulatory Commission Response

Each volume serves, respectively, as the text for a course of instruction in a series of courses for NRC response personnel. These materials do not provide guidance or license requirements for NRC licensees or state or local response organizations. Each volume is accompanied by an appendix of slides that can be used to present this material. The slides are called out in the text.

14 DOCUMENT ANALYSIS a KEYWORDS/DESCRIPTORS
emergency response
severe power reactor accident
licensee and state and local officials

b IDENTIFIERS/OPEN ENDED TERMS

15 AVAILABILITY STATEMENT
Unlimited

16 SECURITY CLASSIFICATION
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17 NUMBER OF PAGES

18 PRICE

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